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CHEMICAL AND TECHNOLOGICAL REFERENCES IN PLUTARCH.

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Introduction.

Plutarch, who lived from about 51 to 124 A.D., in addition to the well-known *Parallel Lives*, also wrote a large collection of smaller writings (more than 80 ?), which are known as the *Moralia* or the *Ethica*. This is not a very appropriate title for the articles which have come down to us and are recognized as genuine, since only a certain number of them concern questions of conduct, whereas the remainder deal with the different branches of the natural sciences, medicine, philosophy, religion, folklore, superstition, etc. In these writings Plutarch appears more or less as a follower of the teachings of Plato, and either completely disagrees with, or even attacks, those Stoics and Atomists who were, in his day, the leading representatives of philosophy.

Throughout his writings, he allows the representatives of the different points of view to express their own opinions and prefers to use either the method of question and answer or simple dialogue. Very often, however, the resolution of a problem, or the final proof which is expected by the reader, is not realized, and the different opinions are just as opposed to one another in the end as they were at the beginning.

* Prof. v. Lippman died in 1941, and consequently the proofs of this article has not been corrected by him.

Plutarch himself usually withholds a final opinion ; but at the same time he is always unprejudiced. He is influenced by the many superstitions of his time, and lacks a definite critical attitude. This is a disadvantage in many of the writings, certainly in the form in which they have come down to us, and this is the case both in regard to the context as well as to their sequence.

In many of the writings, especially, but not only, those which are concerned with the natural sciences, many details are met with which are of interest to the chemist and even to the technologist, although they are not the result of any decisive basic point of view, nor do they represent a harmonious view of the world. The author, moreover, occasionally mentions facts which have come to his knowledge, sometimes as mere suggestions and sometimes in more detail ; as a rule he does not go into these matters deeply, and they were inserted at convenient places in order to interest the reader, and not with a more profound meaning. If this meaning is implied, it is more or less an accident that Plutarch tells us about this or that subject, or this or that point of view.

The sum total of his traditional matter has a certain value for us, because it represents the different currents of thought at the beginning of the second century A.D. held by the representatives of the different schools which were, so to speak, the popular opinion of the ordinary citizen.

The writings of the *Moralia* for the sake of brevity are referred to here by the letters A to Z and *a* to *e*. The biographical articles are referred to by their respective titles. *E.g.*, ' R.III (4), 2 ' refers to *Table Talks*, Book III, Section 4, Chapter 2 ; ' *Theseus*, 17 ' to the Biography of *Theseus*, Chapter 17.

Remarks in square brackets [ ] are by the author.

A. How a Young Man should hear the Poets.
B. How to know a Flatterer from a Friend.
C. Precepts for Health.
D. Origin of Morals.
E. How a man may derive benefit from his Enemies.
F. Virtue and Vice.
H. The E I in Delphi.
I. Decadence of the Oracles.
K. Concerning such whom God is slow to punish.
L. Roman Questions.
M. Greek Questions.
N. Fortune of the Romans.
O. Isis and Osiris.
P. Oracles of the Pythia.
Q. Brotherly Love.
R. Table Talks. (Convivial Questions.)
S. Physical Maxims of the Philosophers.
T. Natural Questions.
U. The First Principle of Cold.

V. Common Conceptions against the Stoics.
W. Number of Friends.
X. Consolation to Apollonius.
Y. Conjugal Precepts.
Z. Superstition.

a. Talkativeness.
b. Love.
c. Platonic Questions.
d. Reason of Animals.
e. The Face in the Moon.

Chapter I.

General.

He who tries to investigate the nature of the Cosmos must realise that we are not able to discover the ultimate essence of things, but are dependent on sense impressions [1]. Dogmatic statements such as ' the Cosmos is composed of an endless mass of atoms in an empty space' reveal themselves at once as completely one-sided opinions, indeed perversions [2]. A widespread and indeed quite probable doctrine is that formerly a single primal matter existed, without form or shape, which was a ' matrix ', and which by means of limited individualisation in the form of a massing and an attenuation caused the coming into being of the four elements, earth, water, air and fire [3]. This was neither more nor less than the present world, but arranged in a new fashion, because even where creation and dissolution seem to be present, this primal matter remains intact, ' as it was'[4], but newly arranged by the ' forces of nature ' which are extended everywhere with the utmost rapidity, and even produce their effects at great distances, either separately or in conjunction [5].

Thus nature creates, ' in the stress of the becoming ', ' by constantly mixing the four elements ', everything in the past, present or future, from the lowest organism to man [6]. All existing bodies are composed either of single separate parts, as, for instance, in the case of various minerals, or of parts united in a certain order of sequence as in a house, or united completely according to plan, as in the case of living organisms [7].

According to another point of view, there existed at first a sole and very fine primal matter, the so-called ' ether ', which can be assumed to be the medium

[1] H. 18.
[2] Z. 1.
[3] S. I (9), 4; S. 2 and 9. W. 9.
[4] S. I, 2; X. 15.
[5] K. 14.
[6] K. 5.
[7] Y. 34.

of light, as air is the medium of sound, and fire, because of its warm vapour, the medium of smell. From this primal matter is supposed to originate, by means of a gradual thickening, fire, then earth, followed by water, created by pressure caused by the rotation of the globe. Finally, out of this water, by repeated thinning air is created [8]. It is not easy to understand why these elements exhibit such opposite attributes, if they have been evolved out of one primal matter [9].

According to another opinion, only four ' principles ' existed at first—heat, cold, dryness and moisture, and, ' by means of that conflict of opposites which preserves the world ', these principles are supposed to have been united, cold and dryness producing earth ; cold and moisture, water ; heat and moisture, air ; and heat and dryness, fire [10]. According to this, therefore, it is not correct to suppose that only like associates itself with like, and that unlike opposes mixing and unification [11].

These assertions are very bold ; (the truth is to be found more or less in essence in the teachings of Plato, namely that it is the four elements which ' build up the sublunary world ', in that the earth lends stability and heaviness to the elements ; fire lends motion, form and colour ; while air and water act as a mediator and unifier [12].

Several authors would not agree that these elements are actually able to pass into each other, whether by means of ' a rising upwards ' according to the sequence earth, water, air, fire, or in the opposite sequence by means of cooling and pressure [13].

Chapter II.

The Elements, Fire, Water and Air.

(1) *Fire* is the carrier of heat, the first cause of all things, and its real nature is motion [14]. It is like the living organisms because of its ability to produce motion and because of other characteristics. Like these living organisms, it boils, effervesces, and needs food [15], the most suitable being completely fluid and of sufficient moistness, for instance, oil [16].

The purest and most powerful fire is the heavenly fire of lightning, which even melts metals, sets alight and consumes most other materials, whereby very often

[8] S. I, 6 ; H. 14.
[9] Q. 13.
[10] U. 7 and 14 ; Agesilaos, 5.
[11] U. 3.
[12] O. 63 ; N. 2.
[13] I. 10 and 34 ; V. 41.
[14] Camillus, 20.
[15] L. 75 ; R. VII (4), 3 ; W. 10.
[16] L.1 ; R. VI (9), 2 ff.

an odour of burning sulphur is noticed, which probably for that reason is called in Greek θεῖον [the divine] [17]. The light of the sun is also filled with the high and beneficent forces of fire, while the light of the moon acts injuriously because of its paleness and coldness [18]. All sorts of plants store fire in different degrees in themselves. Thistledown, for instance, possesses warming characteristics and serves for bed-warming [19]. Different kinds of wood are more appropriate for the working of metals or glass, or for the purpose of heating or medicine [20]. These woods, it is generally asserted, are more efficacious in winter than in summer, probably because the outer cold also contracts fire, and therefore thickens it [21], But this applies only to moderate cold, because a great degree of cold extinguishes fire, which is first transformed into smoke, and after that into air of the degree of density which is nearest to it, namely, fire [22].

In the animal kingdom fire exerts also its force ; for instance, it creates in man a certain warmth which is felt in himself, and indeed in his clothing, and keeps the body healthy by an even distribution [23]. Furthermore, the spirit of some animals, such as the wolf, is of such heat that the hardest bone is dissolved and made fluid in the stomach ; even stones are transformed into digestible food [24]. It is therefore easily understood why this element, so useful in so many directions, has been given the name of the ' noblest of all spices ' [25].

(2) *Air*, which fills the space above the earth and very often steams out of it [26], stands, according to its nature, between the nature of fire, which it approaches in its purest condition, and that of water, into which it is transformed through cold and great pressure [27]. The relationship of air to fire confirms the idea that air, in its union with ether, is inflamed, and thereby leads to the creation of shooting stars [28]. In opposition to certain other opinions, air is not immaterial but takes up a certain space, which can be deduced from the fact that on pouring water into an empty vessel air is forced out [29], and that air is the medium for the transmission of sound [30] ; in this, air is more potent according to the degree of its density caused by cold, which explains why sounds are heard more clearly at night than by day [31].

[17] R. IV (2) 3.
[18] R. III (10) 1 ff. ; U. 9, ff.
[19] Lycurgus, 16.
[20] R. III (10) 1 ff.
[21] I. 4.
[22] L. 75 ; I, 34 ; U. 10.
[23] F. 1 ; C. 2.
[24] R. II (9) 1 ; E. 2.
[25] B. 2 ; C. 8.
[26] A. 11.
[27] A. 4 ; I, 34.
[28] Lysander, 12.
[29] D. 10.
[30] H. 12.
[31] R. VIII (3) 2.

A very loud sound is supposed to rupture the air, so that flying birds fall down out of it, because the medium of their support has been taken away, or else they are struck by the surge rising in the air [32].

Air is very important for breathing ; because by means of this, air strengthens the body, preserves and increases warmth, and induces an even distribution of heat throughout the body [33].

(3) Many think that *water* is the primal and oldest element, out of which the other elements were subsequently evolved [34] ; others say that water was created in the earth, under the influence of cold and pressure, out of the appropriate airy vapours [35], only in this case the pressure must not exceed a certain degree, since too strong a compression is supposed to change water into solid matter [36] [earth]. Spring water originates from mild, sweet vapours, and in its turn is also exhales these vapours, and thereby assists in nourishing the moon [37] ; its usefulness and beneficent action on animals and on plants is contingent on the presence of a certain warmth [38] and a water which is totally lacking in warmth, such as the completely icy water of the Arcadian river Styx, is undrinkable, useless, and of such acidity that it corrodes all vessels and like the poison which was said to have killed Alexander, gathered like a dew from a rock near Nonakris, it can be kept only in an ass's hoof [39]. The fact that cold contracts water and increases its density explains why a quantity of water from certain springs weighs in winter twice as much as in summer. It also makes it clear that in winter water-clocks take longer to run down than in summer [40].

Water that has been previously heated (because it is devoid of air) absorbs warmth very willingly and easily [41]. Certain waters are supposed to be especially useful for the purpose of fixing loose ash and improving metals, especially iron [when it is quenched for the purpose of hardening] [42].

The rising watery vapours unite with air and first of all form a fog [43] ; later they are transformed to rain-water which, because of its formation in the higher spheres, is very rich in *pneuma*, and therefore putrifies much more quickly than spring water [44].

[32] Flaminius, 10 ; Pompey, 25.
[33] C. 2 and 16.
[34] S. IV (1) 1 ; O. 36.
[35] Aemilius Paulus, 14.
[36] H. 18.
[37] O. 41.
[38] L. 1.
[39] Alexander, 77.
[40] T. 7.
[41] R. VI (4) 1.
[42] I. 41.
[43] U. 7.
[44] T. 2.

Quite different from this clear and sweet water is the impure and evil-tasting water of the ocean, which many look upon as having been formed by solidification and from the disintegration of the putrefied excrement of fire. This also explains the uncleanliness of the salt from inspissated sea-water [45]. The salt content gives sea-water an increased density, and enables it to carry on its surface heavier loads than fresh water [46]. There are reports that sea-water in special circumstances can at times change itself back into fresh water [47]. It is known that sea-water does not freeze, therefore it must possess an especially high natural warmth [48]. The vapours which sea-water exhales nourish the sun and the stars [49], but they also assist in the creation of springs, which latter however, curiously enough, give forth only sweet water.

Chapter III.

The Element Earth.

From ancient times the wise men have expressed different and often opposed opinions as to the relation of the element earth to the three others ; this element is the most widespread and the most changeable. Some, indeed, looked upon it as being the element last created when the world was formed ; others, however, thought of it as the first element [50]. A definite opinion cannot be reached in this case, and it is, in addition, impossible to say how the different kinds of earth came into being, from the precious jewels down to common clay.

Nevertheless, even common clay deserves a higher valuation than that usually given it, for out of clay comes the best and purest springs, and furthermore clay is permeated with a certain inner warmth by means of which good clay soils bring forth the most fruitful and mature grain, the grape vines which produce the best wine, and the pine trees which have the greatest quantity of gum and tar [51].

There are totally different opinions concerning salt. Some include salt with the most important spices and healing materials, calling it the real ' soul of life ', and it is supposed to possess such nourishing and enlivening powers that mice if they lick salt at once become pregnant [52]. According to another opinion, it has no proper nourishing matter but is a very useful aid to digestion. Still others hold an opinion, based on the fact that there are eight kinds of taste, and that the salty taste alone is not common to any natural food, that salt is created only by the putrefaction of other substances, and that this causes the very bad

[45] O. 5.
[46] R. I (9) 2 ff ; T. 1.
[47] Dion, 24.
[48] T. 2.
[49] O. 41.
[50] S. I, 6.
[51] R. V (3) 1.
[52] R. IV (4) 3 ; V (10) 4.

taste of sea-water [53]. If sea-water is well filtered so that it is free from its earthy particles, this taste can be eliminated. Therefore, drinkable water springs not only out of clay ground near the shore, but in many places in the sea sweet water can be taken by means of hermetically sealed clay or waxen vessels, which when sunk into the sea-water allow only the fresh water to penetrate through the walls, into their inner parts, but do not allow the salty and earthy particles to come through [54].

Plants also cause a similar filtration, and do not absorb salt from the outside at all. They hold the salt back by means of their fine pores, so that the salt can in no circumstances reach the fruits [55]. Those substances seem to be closer to salt which has been lixiviated from the ashes of burnt wood. This solution has a sharp taste, and because of its special nature is a very good detergent ; the best quality is made from a solution of the ash of the fig-tree [56]. Also, the charcoal which has been left over from burning wood in certain circumstances is a product of the action of fire and a permeation, and has an earthy nature. It is able to burn still further, and gives forth a suffocating and deadly vapour by means of which suicides have made a voluntary end to their lives [57].

A peculiar and special substance found in certain kinds of earth, viz. Electron [amber], is also combustible. It is well known that the magnet possesses a specific effluvium which, like the wind, moves in the air, and by means of which it attracts iron to itself, even from some distance. Electron has a similar quality, but this is active only when the electron is rubbed. It is much weaker and less powerful than the magnet, so that it can attract to itself only the lightest and driest objects, and these, too, only at a very short distance.

If it is asked on what the difference in the nature and the potency of the two effluvia is based, viz., those of the magnet and electron, then there is, so far, no adequate answer [58]. It is not known, also, why amber does not attract the plant Basilicon (*Ocymum Basilicum*), as well as objects moistened with oil. We must be content simply with the fact that experience has proved this to be so [59].

An inflammable liquid called naphtha is formed in the earth, and in the Orient it comes out of the hot fatty ground of some localities, for instance, at Ekbatana, very often along with a vapour having the same inflammable characteristics, so that it catches fire at a distance from a flame. Both are so closely

[53] T. 5.

[54] T. 5. The supposed desalification of sea-water by means of wax vessels may be due to an old error of certain manuscripts, where *kērinon* (wax) replaces *keramon*, *keramion* or *keraminon* (earthen, clay). See the explanation in Lippmann, *Abhandlungen und Vorträge*, Leipzig, 1913, I, 157 f. [and earlier, in Hoefer, *Histoire de la Chimie*, Paris, 1866, I, 99 : ' vase d'argile '. The passage comes originally from Aristotle, *Meteorol.*, II, ii, 17. Plutarch also says, T. 5, that sea-water filtered through clay becomes sweet].

[55] T. 5.

[56] T. 1 ; R. V (9) 1 f.

[57] *e.* 21 ; Caius Marius, 44.

[58] *c.* 7.

[59] R. II (7) 1.

related to fire, and so desirous for fire, that they even draw fire to themselves from a distance. This had been experienced by Kreusa, the second wife of Jason, when she was sent by Medeia a wreath saturated in naphtha, by the combustion of which she lost her life. The warriors of Alexander the Great, when planting poles on the shores of the River Oxus for the royal tent, were greatly surprised when quantities of oil came out of the sand, this oil being rather like olive oil in its shiny surface, smell, taste, and fattiness. And they were more than ever surprised because all this happened when nowhere was a single olive tree to be seen [60].

Quite different from those of the other kinds of the element earth are the qualities and characteristics of the metals, which exist partly as such (*i.e.* metals) and partly in the form of ores from which they must be separated. Especially pure gold, silver and copper are found, and it is very curious that mice will gnaw gold [61]. If gold and silver are smelted a peculiar alloy is obtained [the so-called electron] which is very popular because of its paleness and its mild brilliance [62]. Weapons formerly were fabricated of copper, and caused much less injurious wounds than the present weapons [of iron], because copper and everything containing copper has astringent and anti-putrefactive qualities, as physicians well know. For this reason a few copper nails are driven into meat, especially game, in order to keep it fresh when sent for long distances [63]. The 'brass' which is obtained from copper, especially the so-called 'Corinthian brass' [bronze], was according to some discovered by accident, namely, during the burning of a building in which much copper, gold and silver had been hoarded. According to others, a thief had melted stolen gold in small quantities with copper and silver, to detract suspicion from himself [65].

In reality, however, the brass contains, besides copper, not gold but tin. The latter disappears when melted with copper, and 'quite unexpectedly'. It changes its own nature, as it does that of copper, which it makes denser and heavier, and gives to the alloy a beautiful light colour and lively golden brilliance [16].

These effects of one metal when melted with another go far beyond the effects of the heat of the fire, and do not stand alone; melted bronze poured on that which is cold, softens it more than the fire does.

Iron came into use much later than copper and bronze, the reason being that iron was for long regarded as impure [66].

The Chief Alderman in Plataea was not allowed to touch iron, except in sacrifices, and King Numa would not allow anyone to rake the [holy] fire with an

[60] R. V (7) 2; Alexander, 35 and 57.
[61] Marcellus, 28.
[62] P. 2, ff.
[63] P. 2, ff; R. III (10) 3.
[64] P. 2, ff.
[65] Q. 20; I. 41; *b*, 6, 7.
[66] Pompey, 8.

iron sword [67]. Even the ancient Egyptians called iron ' the bone of [the evil demon] *Typhon* ', and compared the attraction and repulsion of iron by the magnet, which they called ' the bone of [the good god] *Horus* ', with the intelligent motion of the universe which subdued the rugged one, but when restrained and forced back it returned to its former indeterminateness [68].

The mystery of the essence of the magnetic ' effluvia ' was already mentioned in connection with the similar effluvia of electron. Another puzzle is the peculiar fact that the magnet that had been rubbed with garlic is unable to draw iron to itself [69].

Iron came into general use when it was discovered how to give it a very great ' power ' by making it red-hot and quenching it in water, or, better still, in oil, whereby it acquired a much greater hardness and sharpness [70]. The Celtiberians, however, are supposed to have had the same success by burying the iron for a long time in the earth [71]. When hardening was discovered, iron was used for purposes of war, especially because it could give more serious and dangerous wounds than either copper or bronze [72]. The natural and artificially increased hardness of iron can be taken away from it by quenching it in vinegar, which makes iron brittle and useless for any further purpose, and Lycurgus ordered this to be done so as to prevent the Spartan iron money, which he had introduced, from being worked up [73]. Rust also destroys iron, only more slowly ; iron, like most other metals, gives out rust when it ages, or when it touches [stale] oil, and in several other circumstances.

In the very sharp and dense air of certain places, for instance at Delphi, rust is thrown off, so that the colour and brilliance of the metal appear again as in its pristine state [74].

A metal of very peculiar quality is lead. It possesses a specific coldness, according to its nature, so that its solution in vinegar produces the coldest of all deadly poisons [white lead] [75] ; nevertheless, lead cannot withstand a strong natural cold, and experience shows that leaden objects fall to pieces during sharp winter frosts [76]. According to legend, a sea of molten lead exists in Tartarus, next to a sea of molten gold, and in these two seas sinners have to atone for their sins by enduring the action of the incandescent heat and the most extreme cold [77].

[68] Aristides, 21 ; Numa, 14.
[69] O. 62.
[70] *c.* 7 ; R. II (7) 1.
[71] T. 41 and 47 ; U. 13.
[72] *a.* 17.
[73] R. III (10) 3.
[74] Lysander, 17 ; Lycurgus, 9.
[75] P. 4.
[76] R. VI (5) 1.
[77] R. VI (8) 6. [The crumbling of tin exposed to cold is mentioned by Aristotle]
[78] K. 22.

Chapter IV.

The Plant World.

Many and diverse components are exhibited in plants, of the origin of which nothing definite is known ; according to a very widespread opinion either the plants themselves arise in a finished form from the earth, or they are derived from certain closely related substances. This opinion has something in its favour since, for example, roses and violets have an especially beautiful scent if planted next to onions and garlic, because the latter draw into themselves away from the roses and violets all the evil-smelling juices, and store them up [78]. The aromas are strengthened when excess of dampness is liberated, which can be done at times by the absorption of oil. This process is sometimes effected by the plant itself by means of ' coction ' through its interior warmth. But in this process also certain remnants of unclean and earthy particles are collected, and it is claimed that because of these the blossoms have a more delicate scent at a distance than they have at close proximity, only a very short distance being necessary to allow these particles, which are carried along in the scent of the flowers, to fall out [79].

Some plants, like myrrh and incense, possess only an agreeable odour which, during the dissemination of the incense, dispels the damp, dense, unclean air, for instance, those vapours which are dangerous and injurious to health [80]. Other plants contain medicinally efficacious particles of different kinds which stimulate, heat and strengthen the body ; for instance saffron, nard, cinnamon, laurel, cassia, aloe, pepper, and Indian malabathron [betel leaves ?] [81]. Still other plants act, by the great coldness of their juices, as soporifics, like poppy and mandragora [82]. Others again, by means of an even greater coldness, have a poisonous effect, like aconite, poison nettle and hyoscyamus [83]. Certain plants, owing to their peculiar nature, produce oil which is rich in fat and therefore very nourishing. It also exhibits a great content of air, which enables it to clarify turbid substances and to smooth down and calm sea waves excited by a storm [84]. Resin and pitch, related to oils but much denser and tougher, which are sweated out of pine woods, make possible the successful grafting of pears on oak trees, apples on plantain trees, mulberries on fig trees, and pomegranates on myrrh vines, but all conifers are useless for this purpose [85]. Nevertheless, so diverse are the products of plants that many exhibit even more peculiar characteristics. Some give forth a substance which produces coma in fish

[78] C. 10.
[79] C. 10 ; R. I (6) 1.
[80] B. 11 ; O. 80 ; P. 6.
[81] B. 11 ; R. VI (7) 2 ; P. 6 ; *d.* 7.
[82] R. III (5) 2.
[83] R. III (5) 2 ; Demetrius Polyorketes, 20.
[84] U. 13.
[85] R. II (6) 1.

and is useful in catching them, and the juice of figs contains rennet, a very small quantity of which thickens milk and turns it completely sour [86].

The grape vine provides an example of how the juices of plants are capable of great changes. The vine first draws its sweet juices from the ground and pours them into the grapes. If these are then pressed the liquid produced does not show any special characteristics, its sweetness being still present unchanged [87]. But if the grape juice stands for a while, fermentation sets in, a kind of putrefaction which is known, for example, to take place in bread-dough [88]. This contains something alien to the body-juices, something of a penetrating, powerful, hot nature, which induces a condition of intoxication [89]. Even Bacchus knew that cold counteracted this effect, and therefore commanded his followers to wreathe themselves with ivy-leaves, because the property of these leaves is one of great cold [90].

A strong draught of air is not very propitious to fermentation, and is even injurious to the matured wine. It spoils the wine, and takes away the great warmth which makes wine, for example, an antidote to the poisonous nettle. In fact, air gradually turns wine into vinegar, which is so extraordinarily cold that no fire can withstand it [91].

Just as the juice of the grape can go into fermentation, so also can the juice of the palm. This juice causes sharp headaches [92]; even when the sweet edible marrow of the upper part is eaten [if it is not very fresh].

Finally, the extract of grain is also capable of fermentation, and hence we have the famous ' grain wine ' [beer] so popular in the Orient and Egypt. This is very sharp, and softens ivory and makes it pliable [93].

Different kinds of colours appear in the plant kingdom. Their use for dyeing and adornment was forbidden by Lycurgus in Sparta because they were considered to be ' counterfeit ' [94]. But this could not be carried through, even in Sparta. Yellow juices come from, *e. g.* saffron, and purple-red from the scarlet oak [*quercus coccifera*] [95], but this purple cannot be compared with that from the snail, the lightest shade of which costs ten times as much as the ordinary purple if it happens to be in the fashion [96].

Before colouring linen and other woven material, it is washed and cauterised with soap, nitron [impure alkali carbonate], extract of beans and other solutions

[86] Y. 5; W. 5.
[87] S. V. 26; R. III (7) 1 f.
[88] L. 109.
[89] R. IV (1) 2; C. 19.
[90] R. III (1) 3.
[91] R. VII (3) 1 f; R. III (5) 2.
[92] C. 20.
[93] R. III (2) 1.
[94] Lycurgus, 13.
[95] T. 41; Theseus, 17.
[96] Cato Minor, 6; Alexander, 36.

of a similar kind [97]. The cauterising substances, therefore, act by cleansing and purging from unsuitable contents, and are thus very useful [98]. The opinion that the fine soft colour and visible threads of asbestos are derived from plants is incorrect. They are derived from the mineral kingdom, and therefore they can be cleansed in the fire, if they are soiled, and they are found, amongst other places, in certain rocky localities of the island of Euboea, but at the present day only in small quantities [99].

Chapter V.

The Animal Kingdom.

The substances by means of which organisms exist are not differentiated from other substances generally found in Nature, but how the inorganic forms itself into the organic, and what ' principle ', which is undoubtedly necessary for this transition, exists, is not known. This is true already of plants, and even certain intermediate forms, such as truffles, which are, before maturing, more like plants, but are yet not plants, since they are certainly created out of the ground by the potent power of lightning [100].

Just as in this case the element earth plays a rôle, air also plays a decisive rôle in certain processes. For instance, air, by wafting, can fertilize birds, and can develop the unfertilized, formless, and unorganized content of eggs to living young, which solves the old riddle : ' Which was first, the hen or the egg ? ', in favour of the latter [101].

From the element water eels and other fish are developed. Rain water also produces snails [102]. From the element earth spring crickets, grasshoppers, snakes, frogs and mice, and these easily change into field mice at the time of the new moon, especially from the mud on the shores of the Nile in Egypt [103]. From the dampness of tree-trunks, which produces putrefaction, maggots and worms are developed [104], and these are also produced in rejected animal matter, such as hair, nail-parings, and wool [105]. Lice, for example, are produced in the wool of a sheep which has been bitten by a wolf [106], and also from the putrid blood of sick people, and only leave these people as death approaches, because then they have nothing more to eat [107].

[97] C. 22 ; T. 6 ; I. 41.
[98] R. VI (3) 2.
[99] I. 43.
[100] R. II (3) 2 ff ; R. IV (2) 1 ff.
[101] R. VIII (1) 3 ; R. II (3) 2.
[102] R. II (3) 2 ; R. IV (2) 1, ff.
[103] R. II (3) ; R. IV (5) 2.
[104] R. II (3) 2.
[105] O. 4.
[106] R. II (9) 1.
[107] B. 2.

It is well known that many animals contain poisons deadly to human beings. Such a poison which is especially potent is bull's blood, which (or, some say, a quick poison) was used by the great Themistokles to end his own life [108]. [' Bull's blood ' is probably a pseudonym for a poison of blood-red colour about which very little is known.]

Chapter VI.

Appendix.

In opposition to some opinions, Plutarch speaks of the mystical connection between the seven planets and the seven vowels, found in the teachings of the Chaldeans, as well as of the connection between certain letters and numbers [109]. He does not make any reference to alchemy, even in those passages where he would have had an opportunity to do so.

Thus, for instance, he designates certain vessels [bronze or brass] which ' imitate the glow and the glittering of gold ' as ' imitation gold ', and ' counterfeit metal '[110].

His silence with reference to alchemy indicates that alchemy in the second century A.D., the time of the beginning of its development, was practically unknown outside Egypt, the land of its origin and its first development [111]. It is, however, important in relation to the origin of the name chemistry that Plutarch says that the wise priests of Egypt called their land Black-Land, the Egyptian name for black being Chêmî [112], because of the colour of the soil, which was like the [pupil of the] eye. Hoffmann [113], recognised in 1884 that the word χημεία (chemistry), like μαγεία (magic), μεταλλεία (metallurgy), and ταριχεία (embalming), means an action or occupation, in this case with a black preparation (*chêmî*=Greek μέλαν, black), because this black primal substance (as in the myth of Osiris) is the collective basis of every other substance, and each substance must be led back to the black primary substance before further transformation into silver and gold can begin to take place [114].

[108] Themistokles, 31.

[109] H. 4.

[110] B. 2.

[111] [Yet Plutarch is said to have visited Egypt.]

[112] O. 33.

[113] In Ladenburg, *Handwörterbuch der Chemie*, Breslau, 1884, II, 516 f., 525.

[114] *Cf.* Lippmann, *Entstehung und Ausbreitung der Alchemie*, Berlin, 1919, I, 243, 301 ; 1931, II, 63.

RHETORICAL AND RELIGIOUS ASPECTS OF GREEK ALCHEMY.

By C. A. Browne [1].

PART II.

Part I of this paper (*Ambix*, ii, 129) consisted of a general introduction to and a translation of the poem of Archelaos *Upon the Sacred Art*. This, the second part, consists of comments upon that poem and its author.

1. *Resemblances of the Poem of Archelaos to the Poems of Theophrastos, Hierotheos and Heliodoros and to the Prose Treatise of Stephanos* [2].

The four alchemical poems are written in iambic lines of twelve syllables, with the caesura falling usually after the seventh syllable. The line from Archelaos (Id. 344, 10), *γενήσεταί σοι οὐδὲν ὠφελουμένῳ*, is cited as an example. The following prosodic arrangement of long and short syllables is the one usually observed.

⏑ — ⏑ — | ⏑ — ⏑ ‖ — | ⏑ — ⏑ —.

The line from Hood 'And silent as a mummy there I stood alone' is a good equivalent of the metrical style.

As evidences of similarity in the metrical construction of the four poems comparisons have been made with regard to (1) the placement of the caesura, (2) the use of the enclitic *τε* before the caesura, (3) frequency of the prosodic error of making the eleventh syllable long, and (4) the use of the verb *πέλειν* or one of its variants at the end of the line. For the purpose of comparison the same indices were also applied to 200 lines of the iambic poem *De Expeditione Persica* of George Pisides, a Byzantine poet of the seventh century, and to 200 lines of the iambic poem *De Re Medica* of Michael Psellos, the well-known Byzantine author of the eleventh century.

[1] The Hon. Editor deeply regrets to announce the death of the author of this paper. Dr. Browne had authorised him to edit his work in whatever manner appeared to him best. Little or no alteration has been made in the text of the paper, but a good deal has had to be cut out in order to bring it within the compass of *Ambix*, and the remainder has had to be somewhat re-arranged.

[2] The treatise of Stephanos and the poems of Theophrastos, Hierotheos and Archelaos are published in Vol. II of Ideler's *Physici et Medici Graeci Minores*, Berlin, 1842, which will be referred to in the references as Id. with number of page and line. The poem of Heliodoros is printed in Vol. IV of Fabricius' *Bibliotheca Graeca*, pp. 790–797, Hamburg, 1714, and will be referred to as Fb. with number of page and line. The published texts, like the manuscripts, contain numerous glosses, misspellings and other errors. The writer has examined the original codices 2327 and 2249 in the Bibliotheque Nationale of Paris and the 299 and 598 in the Library of St. Mark in Venice.

	Heliodoros	Theophrastos	Hierotheos	Archelaos	Pisides	Psellos
Caesura after seventh syllable	85%	82%	85%	79%	38%	57%
Enclitic τε before caesura	8%	8%	10%	5%	2%	3%
Eleventh syllable long .	4%	5%	7%	5%	0%	1%
πέλειν, or its variants, at end of line ...	4 times	4 times	4 times	3 times	0 time	0 time

Other tests, such as the omission of connectives (asyndeton) and the use of the present participle for the indicative, can also be applied, with the same result. The metrical peculiarities indicate unmistakably that the four poems were all written by the same author.

But it is in the usage of similar words, expressions and rhetorical phrases that the chief argument is found for attributing a common authorship to the four poems. A few parallelisms between the four poems and the treatise of Stephanos are quoted :—

Stephanos (Id. 233, 1–2) : *ἐυχερές ἐστι τὸ πρᾶγμα εὔκολον, σύντομον ...*

Theophrastos (Id. 334, 2) : *ὦ θεῖον ἔργον εὔκολον καὶ σύντομον*

Hierotheos (Id. 337, 18–19) : *πιστο μενον τὸ ἔργον ὡς μηδεύκόπον ἔχοντα, μᾶλλον δ' εὔκολον καὶ σύντομον...*

Archelaos (Id. 344, 29–31) : *μηδὲν λέγειν κενόν τε ἢ πλεῖστον κόπον, ἔχειν δὲ μᾶλλον εὔκολον καὶ σύντομον τὸ ἔργον ...*

Heliodoros (Fb. 791, 66) : *ἀλλ' ἐκ μιᾶς τε φύτλης τὸ κοσμούμενον ...*

Theophrastos (Id. 330, 26–27) : *ἄλλου τινὸς χρῄζοντος, ἀλλ' ἢ τῆς μιᾶς φύτλης φερούσης ....*

Hierotheos (Id. 338, 22) : *μιᾶς πέλων φύτλης γὰρ οὐ μερίζεται ....*

Archelaos (Id. 344, 35) : *ὦ τῆς μιᾶς φύτλης τὸ κάλλος εὐπρεπές.*

Heliodoros (Fb. 796, 250) : *ζῆλον τελούμενος, ἀνδρεία φρενῶν*

Archelaos (Id. 351, 36) : *ψυχῆς γὰρ ἰσχύς ἐστιν ἀνδρία φρενῶν*

Heliodoros (Fb. 797, 265) : *λύτρωσιν εὑρεῖν ὥσπερ ἀμπλακημάτων*

Archelaos (Id. 351, 30) : *εἰς ἀμπλακημάτων δὲ λύτρωσιν φέρων*

Stephanos (Id. 214, 11) : *καὶ τῇ πολλῇ ῥοῇ τῶν δακρύων ....*

Archelaos (Id. 352, 2) : *τοῦ σώματος τὸ αἶσχος ἐκπλύνων ῥοαῖς ἐξ ὀμμάτων σου δακρύων ....*

Heliodoros (Fb. 790, 24) : *φέρουσαν ἀῤῥητόν τε κέρδος καὶ κφάτος*

Theophrastos (Id. 328 12) : *εἰς ὠφελείας κέρδος ὄνησιν φέρον*

Archelaos (Id. 344, 17) : *ἔσται φέρον σοι κέρδος ὄλβιον πάνυ*

Στέφανος (Id. 201, 7 ff.): *τότε τέρπει ὡς ἴων οἰκτήρμων, τότε νικᾷ ἀσωμάτως κατεμβατεῦον . . . .*

Ἀνώνυμος (Id. 345, 8–10): *ἀσωμάτως τοίνυν γαρ ἑνοῦται πάσα ὡς γνοῦσα τὴν οἰκείαν ἐνοικήσεως. κατεμβατεύει ὡς μελάθρῳ . . . .*

Many other examples can be cited to illustrate the close resemblance of thought and word in the four poems and the treatise of Stephanos.

2. *Obscurities of Expression in Alchemistic Literature.*

All the treatises of alchemy, beginning with the earliest writings and continuing down to the latest compositions of the eighteenth century, are characterized by the greatest obscurity of expression.

The Graeco-Egyptian shop-recipes for gold-making of the early Christian era are simple directions for counterfeiting the precious metals by making various alloys of lead, copper, tin, mercury and silver to which, in a state of fusion, were added varying amounts of cinnabar, red oxide of copper, pyrites, litharge, smelter-dust and other yellow-coloured or reddish metallic substances that were expected to give the alloy a colour resembling that of gold. These recipes vary in the nature of their combinations, and because of the lack of a definite nomenclature a difference of opinion early arose as to the nature of such expressions as Spanish tutty, Persian talc, Chian earth, Attic ochre, Italian stibium and the like.

In the course of time, because of unsuccessful efforts to duplicate the results of the early recipes, the opinion became prevalent that the old practitioners had intentionally made use of obscure expressions. In his treatise upon 'The Four Substantial Bodies' Zosimos, an alchemical Greek writer of the fourth century, remarked, 'If these things were useful they accepted them in their treatments but referred to them by means of enigmas and for this reason they are a mystery'. By the time of Zosimos deliberate obscurity of expression was the fashion in alchemy; minerals, metals, and apparatus were frequently mentioned not by their actual names, but by a multitude of cryptic terms to which only a few of the initiated had the key. Zosimos, for example, describes mercury as 'the silvery water; the masculine-feminine; the ever-fugitive; that which hastens unto its own; and the divine water'. Again, in a Greek alchemical lexicon, mercury is variously mentioned as 'seed of the dragon', 'bile of the dragon', 'dew', 'milk of a black cow', 'sandarach', 'Scythian water', 'water of silver', 'water of the moon', 'river water', and 'divine water'. Mercury, from its fluidity, was again called the 'sea' and 'sea water' (*θαλάσσιον ὕδωρ*), this being the origin of the Latin *aqua maris*, a later mediæval designation for mercury. According to Stephanos, who quotes the opinion of early writers, the old practitioners of the art employed enigmatic and obscure expressions because they wished to sharpen the wits of their pupils and to conceal the secrets of their art from the uninitiated. He repeatedly declares,

' I shall make the enigmatic doctrines of my predecessors the subjects of clear inquiry ', and then proceeds in characteristic manner to make his subject still more unintelligible.

As a result of Christian ecclesiastical influences the ambiguities of alchemy were still further intensified. Chemical operations such as washing, dissolving, melting, digesting and distilling, which were clearly enough indicated in the old technical works, were referred to under such terms as baptism, mortification, death, burial and resurrection. As man was held to be a microcosm of the great universe, so each metal was held to be a microcosm of man. ' Thus copper, the same as man, has both a soul and a spirit ', to quote again from Stephanos, ' for these fusible and metallic bodies are so constituted that whenever they are calcined in contact with fire they are again spiritualized by the fire granting them a spirit ' (Id. 210, 11–14). The transmutation of copper into gold was to be accomplished by endowing the body of copper with a new soul and a new spirit.

With the spread of astrological conceptions, the influence of the heavenly bodies upon the transmutation of metals became an established principle in Greek alchemy and the literature upon the subject was overspread with another layer of obscurities. Gold was referred to as *Helios*, silver as *Selene*, mercury as *Hermes*, copper as *Aphrodite*, iron as *Ares*, tin as *Zeus* and lead as *Kronos*, and the astrological signs of these heavenly bodies were employed to designate the respective metals. But these and other signs were differently employed [3], the symbol ☿ for Mercury being applied by some writers to tin and by others to quicksilver. To the latter substance as the counterpart of silver the sign ☾ of the old moon was employed by some writers, the opposite crescent ☽ of the new moon being reserved for silver. Confusion of these and other similar signs caused differences of interpretation and many of the texts became in this way corrupt.

Thus it happened that by a gradual process of syncretism old shop recipes of the metal workers, Egyptian magic, Greek philosophy, Jewish gnosticism, Chaldean astrology, Christian theology and Pagan mythology were combined into a confused allegorical system of chemical philosophy to which was given the name of the ' Sacred Art '. In order to give their vague mystical doctrines a semblance of authority the alchemical writers published various pseudographs under the names of Hermes Trismegistos, Moses, Demokritos and other celebrities of Egyptian, Jewish, Persian and Greek origin, and it is probably because of this practice that the name of the eminent philosopher Theophrastos was selected by the author of the alchemistic poems as one of his several *noms de plume*.

The final phase of the delight of the Greek alchemists in figurative expression was the complete subordination of the physical act of transmutation to its

[3] A list of metals of the second century, cited by Berthelot, assigns tin to Venus and iron to Mercury (*Collection des anciens Alchimistes Grecs*, Introduction, p. 79).

allegorical symbol,—the conversion of lead and copper into gold being held up as a picture of the regeneration and transformation of man's own base nature into something nobler and higher. Hence came the moralities and religious exhortations which make up so large a part of the treatises of Stephanos and of his later imitators.

3. *The Alchemical Process in the Poem of Archelaos.*

In lines 62–77 of the translation [4] Archelaos gives a vague allegorical description of the first step in transmutation, which consisted in purifying the body of copper for the reception of the new soul and spirit that were to convert it into gold. The stages of the process are indicated only very obscurely, but enough is known from other sources to form a general picture of the operation, which has been fully described by the writer in his commentary upon the poem of Theophrastos.

Copper, which had previously been purified by a process of derusting (*exiosis*), was combined with silver and converted into a light-coloured alloy. In the mystical language of alchemy the body of copper was slain in this treatment and, becoming endowed with the soul of silver, was regenerated as a new being. But to perfect this combination there was needed the spiritualizing action of an intermediary which, having a certain kinship to both copper and silver, was able to bring them into a state of more perfect union. This intermediary, as pointed out in the writer's commentary upon the poem of Theophrastos [5], was mercury which from its volatility was held to be a spirit and incorporeal. Copper in the mystical language of Greek alchemy was a man whose bride was silver, while mercury the intermediary was of double gender, the noun being either masculine or feminine according to the alchemists. Archelaos (Id. 345, 4–10) states that mercury, from its kindred relationship to copper and silver, penetrates and enters into the body of these metals, recognizing them as of her own household and taking possession as if within her own home, all of which is a vivid poetic picture of the process of amalgamation. After a long period of gentle heating (Theophrastos, Id. 332, 7–9, buries the receptacle in warm fermenting horse manure for twenty days), during which the union of copper with silver was supposed to be perfected, the earthenware alembic containing the amalgam was heated upon a hot fire in order to remove the mercury by distillation. According to the poetic account of Archelaos (Id. 345, 14–26) it is the controlling nature of mercury which directs the process. She brings the mixture into fire, and enables it to contend with fire and overcome its vehemence, producing a 'shapely change of form' of the residual alloy into a new body that is to be a fitting receptacle for the tinctorial spirit which

[4] *Ambix*, ii, 132.

[5] The Poem of the Philosopher Theophrastos upon the Sacred Art; a Metrical Translation with Comments upon the History of Alchemy, by C. A. Browne, *Scientific Monthly*, Sept. 1920, pp. 193–214.

is to transform it into gold. This new body, however, cannot unite with this tinctorial spirit unless its nature be freed from corruption and separated from the grossness of matter. This purification was supposed to be accomplished by the elimination of the black dross and scum of oxides which were formed in the process of amalgamation and fusion, these, according to the alchemists, being the preponderance of earthy impurities in the base metals. By the rejection of this earthy matter the nature of the new body was made of finer quality. The mercury which is liberated in the distillation from the amalgam becomes like a spirit. This extended paraphrase, which is based upon the scattered accounts of the process for transmuting copper as given by other Greek alchemists, is necessary in order to understand the vague description given in the lines of Archelaos.

There follows a discussion concerning the four elements which introduces little or nothing that is unfamiliar. The author then returns to the more practical phase of his subject (ll. 132–185). He discusses the interconversion of the qualities of heaviness and volatility, where the familiar contrast appears again between downward and upward. The heavy corporeal nature of copper sinks downward while the volatile nature of mercury rises upward. The combination of these two opposite natures is one of the chief problems of alchemy. Mercury as a spiritual substance cannot be felt and handled until it has been fixed by a body that has been previously refined from its gross earthy nature by the removal of its rust or *ios*, and is made suitable for retaining the spirit which it is to keep. The brilliant spirit of mercury is akin to the milky white and shining essence of silver, their two friendly natures loving, controlling and shaping each other by penetrative action (*i. e.* amalgamation).

The removal of mercury from the amalgam of silver and copper, previously mentioned, is now more fully discussed in the usual figurative way. The displacement of the soul of mercury from the body of the amalgam can be done, however, only by a technical operation, as any wise man knows who has been trained in the knowledge of divine things. The mercury, upon being distilled away, is freed from the murkiness which concealed its shining beauty as within a dark prison. The residual alloy of copper and silver is then cleansed from its dark-coloured corrosion (*i. e.* metallic oxides), which the alchemists supposed to be the excess of earth in the base metal, by skilful trituration and repeated washing. It is next calcined by plunging into fire and any additional blackness removed by repeated cleaning and washing.

The residual metal in the alembic is then subjected to renewed treatments with mercury for further purifications, which are indicated by such allegorical expressions as 'guiding it into divine liquid' and 'dipping it in the sea', such enigmatic expressions being used by the Greek alchemists to indicate mercury just as 'aqua maris' was similarly used by the later mediæval alchemists. The mercury of these successive amalgamations was again removed by distillation. Archelaos states (Id. 348, 11, 12) that the bath of mercury

reveals the actual essence of the new metal which was formerly ocean-coloured. He probably refers here to the greenish corrosion or *ios* of tarnished copper which does not exist in the new copper-silver alloy.

In the distillations of the amalgam its solid earthy substance first melts, then yields a vapour which condenses and runs down in streams. These changes of state are the obvious parallels of the conversion of earth into air and air into water, which Archelaos has mentioned previously in his philosophic argument. The mercury which was condensed during the distillation of the amalgam was probably collected under running water, its gleaming appearance being compared with that of a shining nymph who hides herself within streams of the Nile.

Soul and Body Symbolism, ll. 198–255.

We now come to what, in a rhetorical sense, is the most striking part of the alchemistic poem of Archelaos, which is the apostrophe, or imaginary address, of the soul of mercury to the dead body of copper lying in its tomb. This passage is an extended poetic imitation of a similar apostrophe by the soul of mercury which occurs in the last part of the ninth book of the alchemistic treatise by Stephanos (Id. 251, 23–27). The second half of the ninth chapter of this treatise, as it exists in Ideler's edition, in the codex of St. Mark and in other manuscripts, was shown, however, by Berthelot [6] in 1885 to comprise the final three-fourths of another alchemistic work called the ' Book of Komarios ', which had been attached to the conclusion of the work of Stephanos by the error of a compiler.

The *Book of Komarios* [7] is one of the most interesting documents in the collection of Greek alchemistic manuscripts, as it exemplifies so completely the mystical element which predominated during the final decline of Greek science. Several pages of this work, as given in Ideler's edition of Stephanos, are herewith translated both for their intrinsic interest and as an illustration of the source material from which the alchemistic poem of Archelaos was taken. The section selected is part of an exposition by a female alchemist Kleopatra before Ostanes and other philosophers upon the mystical philosophy of her teacher Komarios.

[6] This question has been extensively discussed by numerous workers. (*a*) M. Berthelot *Les Origines de l'Alchimie* (1885, p. 349); *Collection des anciens Alchimistes Grecs* (*Introduction*) (1888), pp. 179–83. (*b*) Reitzenstein, Zur Geschichte des Alchemie und des Mystizismus, *Nacht. Kgl. Gesells. Wissenschaft. Gottingen. Philol. Hist. Kl.* (1919), pp. 1–37. (*c*) O. Lagercrantz, Ueber das Verhältnis des Codex Parisinus 2327 zum Codex Marcianus 299, *Cat. des Manuscripts Alchimiques Grecs*, Union Académique Internationale, Bruxelles. Vol. II, Appendix.

[7] Reitzenstein (*loc. cit.*) has made an interesting study of this work which he believes to contain ideas of Iranian-Chaldean origin. He thinks the original to have been an Aramaic alchemistic text which was translated into Greek with various errors. He supposes the name Komarios to be derived from a mistranslation of the word Chomar, meaning a priest.

Ostanes, and those who were with him, replied to Kleopatra and said, ' In thee is concealed the whole of the awful incredible mystery. Illuminate our minds with a far-shining light in regard to the elements. Tell us how the highest descends to the lowest and how the lowest ascends to the highest and how the intermediate approaches the highest and the lowest and how the parts do not separate in advancing and being united to the intermediate and which of the elements belongs to them ; also how the blessed waters descend to visit the dead who lie prostrate, shackled and afflicted in darkness and gloom within Hades and how the medicine of life penetrates and awakens them so that they are aroused from sleep in their beds ; also how the new waters penetrate, which are brought forth at the commencement of, and during, the confinement and which come with the light, a cloud bearing them aloft. And the cloud rises from the sea, bearing aloft the waters which, as they are made manifest, the philosophers delight to behold '.

And Kleopatra said to them, ' The waters that penetrate awaken the bodies and the spirits which are imprisoned and powerless. For again ' she says, ' they endured affliction and again will be shut up in Hades. But little by little they grow and ascend and clothe themselves in various colors, resplendent as the flowers in spring ; and Spring herself is pleased and rejoices in the beauty which they have put on.

' I speak to you as to people well-disposed. Whenever you take up plants and elements and stones from their places, they appear very beautiful. But they are not beautiful until fire doth test them all. When, however, they clothe themselves with the glory and conspicuous color which come from fire, then the beauty that is sought after and the divine transformation by fusion are revealed in greater splendor, because of the hidden glory. For these things are nourished in fire, just as the embryo, nourished in the womb, grows little by little and, when the appointed month draws near, is not prevented from coming forth. So it is also with this admirable art : the billows and the waves assail them one upon the other, in Hades and in the tomb in which they lie. But when the tomb shall be opened they will ascend from Hades, just as the babe comes forth from the womb.

' The philosophers contemplate their beautiful work, just as an affectionate mother does the babe which she has borne, and then seek how they may nourish it, just as the mother does her infant, employing, however, for this art the waters instead of milk, for the art imitates the infant, since it is formed even as the babe is formed, and when it shall be brought to perfection in all things, behold the mystery which is sealed up within.

' But now I will tell you clearly where the elements and plants occur and I will begin by speaking in riddles. Ascend to the topmost place in the rough mountain among the trees and, behold, there is a rock in the mountain ridge ! From this rock take arsenic and use it for the divine process of whitening. And, behold, in the middle of the mountain below the male is his consort to whom he is united and with whom he delights, for nature rejoices in nature and without her there is no union. Then descend to the Egyptian sea and bring up with thee from its source in the sand the substance called nitrum and unite it with the other things and

it brings forth the all-tinging beauty and without it there is no union for the consort is the measure thereof. See how nature corresponds to nature and when thou dost assemble all things together in equal measure, then natures conquer natures and delight in one another.

'See, ye wise men and understand! Behold the fulfillment of the art in the joining together of the bride and groom and in their becoming one! Behold the plants and their different kinds! Behold I speak to you all the truth and again I will say to you: See and understand that the clouds, which bear aloft the blessed water, ascend from the sea and they water the lands and cause the seeds and flowers to grow. Similarly also our cloud, coming forth from our element, bears aloft the divine waters and gives drink to the plants and elements and requires nothing from other earths.

'Behold, my brothers the incredible mystery which is wholly unknown! Behold the truth has been revealed to you. See how you water your earths and how you nourish your seeds, that you may cause the fruit to be borne in its season! Hear, therefore, and understand and examine closely into what I say.

'Take from the four elements the arsenic which is highest and lowest, the white and the red, the male and female in equal balance, in order that they may be joined to one another; for just as the bird, with her heat warms her eggs and brings them to their appointed term, so do you also warm your composition and bring it to its appointed term; and having borne it out and caused it to drink of the divine waters in the sun and in heated places cook upon a gentle fire with virginal milk, keeping it from the smoke. Then shut the ingredients up in Hades and stir carefully until the preparation becomes thicker and does not run from the fire. Then remove from the latter and when the soul and spirit are unified and become one, project upon the body of silver and thou wilt have gold such as the treasuries of kings do not contain.

'Behold the mystery of the philosophers which our fathers swore to you neither to reveal nor to publish! It has a divine form and a divine activity. For that is divine which, by union with divinity, renders substances divine. In it the spirit acquires a body and mortal things acquire a soul and, by receiving the spirit which escapes from the ingredients, are overpowered and overpower one another. For the spirit, which is full of vanity and weakness of heart, overpowers bodies so that they are not whitened and do not receive the beauty and color with which they were endowed by the creator. For the body and the spirit and the soul are made weak because of the darkness that extends over them.

'But when the spirit of darkness and of foul odor is rejected, so that no stench and no shadow of darkness appear, then the body is clothed with light and the soul and spirit rejoice because darkness has fled from the body. And the soul, calling to the body that has been filled with light, exclaims: "Awaken from Hades! Arise from the tomb and rouse thyself from darkness! For thou hast clothed thyself with spirituality and divinity, since the voice of the resurrection has sounded and the medicine of life has entered into thee." For the spirit is again made glad in the body, as is also the soul, and runs with joyous haste to embrace it and does

embrace it. Darkness no longer has dominion over the body since it is a subject of light and they will not suffer separation again for eternity. And the soul rejoices in her home, because after the body had been hidden in darkness, she found it filled with light. And she united with it, since it had become divine towards her, and it is now her home. For it had put on the right of divinity and darkness has departed from it. And the body and the soul and the spirit were all united in love and had become one, in which unity the mystery has been concealed. In their being united together the mystery has been accomplished, its dwelling place sealed up and a monument erected full of light and divinity. For fire has unified and transformed them and from the hollow of its womb they have gone forth, exactly as from the womb of the waters and of the air which ministers to them. And fire brought them forth from darkness into light, from sadness into joy, from sickness into health, and from death into life. It clothed them with a divine spiritual glory such as they were not clad with before. For in them has been concealed the whole mystery which exists as something divine and unchangeable.

'For the bodies coalesce with one another because of their virtue. In coming forth from the earth they clothe themselves with light and a divine glory, since they have grown according to nature and have undergone a change in form and have arisen from sleep and have gone forth from Hades. For the womb of fire has given them birth and they have clothed themselves with a glory therefrom. It has brought them to a single unity; their likeness has been perfected in body, soul and spirit and they have become one. For fire has been subjected to water, and earth to air, in the same way as air with fire, and earth with water, and fire and water with earth, and water with air, and they have become one. For the one has been formed from plants and vapors; and from natures and from sulphur a divine substance has been produced that pursues every nature and overpowers it. Behold, natures have overpowered and conquered natures and thereby they change natures and bodies, as well as all things which proceed from their nature. Since the fugitive has entered into the non-fugitive and that which overpowers into that which does not overpower and they have been united to one another.

'This is the mystery which we learned, my brothers, from God and from our fathers, the high priest Komarios. Behold I have spoken to you, my brothers, all the truth that has been concealed with many sages and prophets.'

Then the philosophers said to her, 'Thou hast amazed me, O Kleopatra, with what you have told us. For blessed is the womb that bore thee'.

It is interesting to observe how Archelaos, the alchemistic poet and rhetorician, paraphrases and elaborates the mystical address of the soul of mercury to the dead body of copper and converts it into a dialogue in which the dead body of copper is also supposed to take a part.

This concludes the practical part of the poem of Archelaos, the description of the work not being continued to the final phase of the act of transmutation, which consisted in imparting a yellow colour (the *xanthosis*) to the alloy of silver and copper which was left after the separation of the mercury from the

repeated amalgamations. This final part of the process consisted in adding the tinctorial powder or spirit, which consisted of various ingredients such as sub-oxide of copper, pyrites, cinnabar, orpiment, litharge, the metallic oxides of smelting works, or any other substance whose yellow colour might be a recommendation. The details are described in the writer's commentary upon the alchemistic poem of Theophrastos [8] to which reference is made for additional particulars.

The concluding fifty-four lines of the poem of Archelaos are devoted, as in the other alchemistic poems, to religious and moral admonitions. The transmutation of copper into gold, described in allegory, is now made itself an allegory descriptive of the transformation of man's own base nature through the converting agency of religion. The various chemical processes have each a religious parallel, the corrosion or ἴωσις of copper corresponds to the mortification of the flesh ; the washing away of the dross of oxides corresponds to the purifying action of tears of repentance ; the heat of the furnace finds its counterpart in the fires of Gehenna ; while the brilliant gold, ' such as the treasuries of kings do not contain,' represents the spiritual man ' made godlike by the light of holy deeds '. This is the real interest of Stephanos and the authors of the alchemical poets. Doubtless they believed in the possibility of transmutation, but it is unlikely that they had a practical acquaintance with the laboratory. They were, however, powerfully interested in matters of religion, and the chief significance of alchemy to them was that of a religious symbol.

[8] Browne, *loc. cit.*, note 5.

LE LIVRE DE LA TRÈS SAINTE TRINITÉ

By Denis Duveen, F.R.I.C.

The Codex which we now describe and which bears the above title is first found referred to by Stanislas de Guaita in his *Clef de la Magie Noire*, (Paris, Chamuel, 1897 : p. 805). It also figures in the catalogue of his books and MSS., issued by Dorbon in 1899 (Item 1591). It consists of an extremely legible and well-written French text, which occupies the first 208 leaves (paper), followed by 25 curious miniatures on 14 leaves of vellum. These miniatures are superbly executed in colours heightened with gold and silver and are remarkably fresh, probably due to the fact that they have been interleaved with blank leaves of vellum : de Guaita's catalogue contains reproductions of two of these miniatures. The present work, a large folio, was written and illuminated in the first half of the XVIIth century and is now bound in a handsome full citron polished calf, gilt back, binding dating from the latter quarter of the XIXth century.

The text consists of an alchemical treatise veiled in Christian symbolism, the author explaining the transmutation of metals by means of the allegory of the redemption of sins. As has already been pointed out elsewhere by the author [1] the comparison between chemical operations and the Passion of Christ, and the allegory of the fall of mankind representing the destruction of impure or base metals is met with in some early authors, *e. g.* the *De Secreto Naturae* ascribed to Arnaldus de Villanova, and in the works of George Ripley, and many later ones, *e. g.* Petrus Bonus. Professor C. G. Jung [2] has also dealt at some length and from his particular point of view, with the Idea of Redemption in Alchemy, and has drawn some of his conclusions from a study of the series of illustrations in the Munich State Library manuscript of the work under review. The principal object of the present communication is to deal with the symbolic miniatures,—it is hoped that the text may be the subject of a further paper. We possess no certain clues as to the identity of the scribe or place of origin of the MS., but internal evidence, to be dealt with in the analysis of the text, points to the scribe having been a Franciscan monk, living in a monastery near the Eastern Franco-German border about the year 1650 and being thoroughly conversant with the works of Basil Valentine. Certain of the miniatures, in particular Nos. 5, 6, 9 and 11, seem to be directly inspired by the illustrations which are to be found in a rare book called *Pandora, das ist, die edleste Gab Gottes, oder der werde und heilsamme Stein der Weisen*,

[1] *The Library*, I, 58, 1946.

[2] *The Integration of the Personality*, London, 1940, pp. 205–280.

mit welchem die alten Philosophen auch Theophrastus Paracelsus, die unvolkommene Metallen durch gewalt des Fewrs verbessert, by Hieronymus Reusner and first published at Basle in 1582. Ferguson [3], however, points out that these figures were probably widely known before the publication of Reusner's work.

During the Middle Ages alchemical literature was generally written in Latin, but an anonymous author produced a German Alchemy, called *The Book of the Holy Trinity*, at the time of the Council of Constance (1414–1418); our Codex is a version of this work which was dedicated to the Burggrave Frederic of Nuremberg, whom we may note to have been the first Markgraf of Brandenburg from the house of Hohenzollern. Several early copies (*i. e.* previous to 1450) of this work are known to exist in Germany, and having had the opportunity of comparing the text and illustrations of our copy with those of the one in the State Library of Munich (Codex Germanicus 598), through the courtesy of the Director, we find that the text and the miniatures correspond in both codices.

It is interesting to note that the author tells us that he delivered a resumé of the work, which was partly composed during the Council of Constance, to the Emperor Sigismund who was attending the Council. Now the Emperor, in 1408, had married Barbara von Cilli, who is known to have been in Constance in 1414; and whilst it does not seem certain as to whether she was already interested in Alchemy at this time or if she influenced her husband in this direction, we do know (according to the alchemist Johannes de Laaz) that after becoming a widow in 1437 she practised alchemy assiduously and possibly fraudulently.

In this connection we may also observe that whilst this work is one of the best examples of the use of a Christian allegory to depict the accomplishment of the alchemical 'Magnum Opus' it also had in its original form a political bias which is clearly seen from the dedication to the Burggrave Frederic in which the author presents his recipes to Frederic as a divine revelation and at the same time invites him to make himself ruler of the Empire and to restore the true Christian faith—this latter idea having been prevalent at the time of the Council of Constance.

It is worth remarking that the present work seems to be the first to mention the hermaphroditic Hermetic Androgyne so frequently found in later works.

During the course of the description of these miniatures, which is now to follow, frequent reference to *Pernety* and *Poisson* will be found; these will refer to the *Dictionnaire Mytho-Hermétique* (Paris 1758) and *Théories et Symboles* (Paris 1891) of these two authors respectively. The interpretations of the miniatures given below are chiefly based upon the explanations of alchemical symbolism and expressions given by the above authors.

[3] *Bibliotheca Chemica*, II, 259.

The first plate consists of five separate miniatures which, from the text, we may deduce as representing the struggle between the five Divine and the five diabolic human senses. These, taken in detail, are :—

(1) A leprous man hung on a golden gibbet—*calcination.*

(2) A leprous man kneels with his hands tied behind his back and is about to suffer decapitation by an executioner, also leprous, armed with a sword and clad in green—*distillation.*

(3) A leprous man attached to a gilded wheel—*coagulation.*

(4) A silver chalice and three dice—*solution.*

(5) A woman-serpent crowned with a golden crown and having a leprous bust with the lower part of her body green, transpierces with a golden lance a leprous man, while a leprous woman stands beneath the lance. This figure represents the extraction of the philosophic Mercury from the prima materia by means of the philosophic fire.

The whole plate represents the exaltation of the common base metals which are throughout considered allegorically as in a state of sin. The idea of the five purifications of the materia prima is frequently met with in alchemical literature (*Pernety*, pp. 417–418).

The second plate is devoted to Jesus, the Virgin Mary and the Holy Ghost. It can readily be divided into three sections :—(1) Jesus clad in a green coat with a golden halo faces the Holy Ghost, represented by a silver dove also with a golden halo—between them a green crown. This symbolises the regimen of Venus (Copper) and is a stage in the Great Work commonly met with. (2) Jesus, clad in a red coat, with a golden halo and bearing a golden orb in his left hand, sits next to the Virgin Mary, who is wearing a blue cloak and blue crown with a golden halo. Between Them, on the ground is a red crown ; by the side of the Virgin Mary, also on the ground is a blue crown ; above, and to the left is a dark grey crown and below a light grey one. This would appear to refer to the preparation of the masculine and feminine principles through the regimen of Jupiter (Tin)(Cf. *Pernety*, pp. 230, 267, 295). (3) Seven crowns in the colours of the seven metals and seven planets in the order of Mars, Venus, Moon, Jupiter, Sun, Saturn, Mercury. We are warned in the text that deliberate inversion of the order of operations has been made in the text and so it is not surprising to find that this order differs from that given by both Philalethes (*Poisson*, pp. 117–119) and Pernety, pp. 121–122.

The third leaf bears representations of the vessels to be used in the Great Work and the symbols of the four Evangelists. The first chemical vessel is a flask and symbolises the Philosophic Egg in which the Material is to be placed (*Poisson*, pp. 117–119). The second is a simple pelican used for cohobation (*Pernety*, pp. 82 and Salmon, *Dictionnaire Hermétique*, p. 29). Then follows

the double pelican employed for circulation (*Pernety*, pp. 82 : *Salmon*, op. cit., p. 27). The last figure represents an alembic or distillatorium in an air-bath ; this seems to be indicative of the need for maintaining a comparatively low temperature—the text is full of allusions to the importance of moderating the fire (cf. *Pernety*, pp. 164–165).

The four evangelists are represented by (1) A red winged bull with silver horns, near it a red crown, (2) An angel clad in a green coat over a white robe, and near him a green crown, (3) A black eagle with a black crown nearby, and (4) a grey winged lion with a grey crown near. Each of the four is adorned with a golden halo. These figures represent at once the four elements, the four principal stages in the work and the four cardinal virtues. From the text we take the following tables :—

(1) Humilitas, Lucas, Mars, Ignis, Bos, Anima.

(2) Pietas, Matheus, Angelus, Virgo, Venus, Aqua, Homo, Corpus.

(3) Sobrietas, Joannes, Saturn, Terra, Aquila.

(4) Castitas, Marcus, Jupiter, Aer, Leo, Sapientia.

The text abounds with references to this plate.

The fourth illustration contains but a single figure—a seven-spoked wheel : the spokes being mauve with silver ornamentations. Each of the spokes has a triple ray in red, blue and red issuing from it, and terminating in an external concentric circle. This symbol represents the seven metals issuing from the central fire or as the text puts it vitriolus earth. The three rays representing the three principles of each metal ; *Earth*, the central blue and *Sulphur* and *Mercury* the two red rays (cf. *Poisson*, p. 19).

The fifth plate also contains but a single figure which is that of Jesus, crowned with thorns and a silver crown with a golden halo. His hands and feet and side bear the wounds from His crucifixion and issue from the body of a double-headed black eagle. This alludes to the stage of the regimen of Saturn in the accomplishment of the Hermetic Work. In His right hand (the creative side) Jesus holds a red crown (Mars) surmounted by a golden eagle ; in His left hand (the passive side) He holds a golden crown (Sun) also surmounted by a golden eagle. A triple-headed silver eagle surmounts the golden halo and this represents the three principles of the Material, *i. e.* Sulphur, Salt and Mercury. The figure's feet stand on two human faces which form the apexes of a lozenge which is coloured half in red and half in green, the colours of Mars and Venus, symbolic of the union of opposites. The face corresponding to Mars is crowned with a blue crown (Jupiter) and that corresponding to Venus with a black crown (Saturn). One of the most noteworthy features of these miniatures is the very great importance apparently attached to colours [4].

[4] *Cf.* Hopkins, *Alchemy, Child of Greek Philosophy*, 1933.

The next illustration represents the coronation of the Virgin Mary, accompanied by the symbols of the four evangelists. This symbolises the completion of the Great Work ; God the Father, robed in red (Mars) holds in His right hand, and Jesus robed in Green (Venus) in His left hand the crown which They have just placed on her head, the Virgin Mary being dressed in blue (Jupiter). Above her is found the Holy Ghost represented by a silver (Moon) dove ; above the Father is a dark grey (Mercury) winged lion, symbol of St. Mark, with a shield bearing a silver lion on an azure background and underneath Him the red (Mars) winged bull, symbolic of St. Luke, with a shield bearing a silver sword with golden hilt, pointing downwards and crossing a golden key on a black background. Above Jesus is a black (Saturn) eagle, symbol of St. John, perched on a shield bearing a black two-headed eagle on a golden ground ; below Him an angel, symbol of St. Matthew, clad in green (Venus) and bearing a shield with black and red chequers. Between the Bull and the Angel we find the armorial device assigned to the Virgin Mary—on a green background the Jesus-Mary Androgyne supports a flesh-coloured double-headed eagle heightened with gold. This device refers to the double nature of the Hermetic Work and at the same time to the double process of the Redemption ; it is frequently referred to in the text where the shields accompanying the evangelists' symbols are also dealt with.

The seventh plate consists of five figures demonstrating the methods to be employed in the utilisation of the Fire in the achievement of the Work. The figures of various chemical apparatus are evidently intended to convey the different specific stages of the work, all requiring a particular degree of heat ; the text emphasises repeatedly that careful regulation of the degree of heat is of fundamental importance. The woman-serpent holding a lance symbolises the Fire ; the lance and all cutting or wounding instruments being well-known as representing Fire (cf. *Poisson*, p. 110) ; the woman-serpent may be considered as related to a serpent which is often the symbol of the Philosopher's Mercury (*Pernety*, p. 461).

The eighth miniature contains four further figures of apparatus and again indicates that the different degrees of heat are to be used ; in this case a progressive increase in temperature seems to be indicated ; this is referred to in the text.

The ninth plate is a representation of the Grand Hermetic Androgyne and the sun and moon trees. The symbol represents union of Sulphur and Mercury, the Masculine and Feminine principles (*Poisson*, pp. 60, 64, 70, 92 ; *Pernety*, pp. 32, 33, 191, 192, 426, 427). The king forming the right-hand (creative side) and the queen the left-hand (passive side) of the figure. The king's vestment is half black (Saturn) and half red (Mars), that of the queen half gold (Sun) and half white (Moon). The king holds a curled serpent, symbol of the philosophical fire, in his hand while the queen holds a cup containing three serpents symbolic of Sulphur, Mercury and Salt (cf. *Poisson*,

pp. 12, 55). From under the king's foot flows the source of nourishment for the roots of the sun-tree and the source for the moon-tree flows from under the queen's foot ; these sources are heightened with gold and silver respectively, indicating the use of the philosophically exalted metals in the Work. Between the trees a double-headed dragon, the dragon of Mercury, which we find referred to in the text, attacks these sources.

The tenth leaf is illustrated with three separate figures :—(1) Jesus, bearing the five wounds from his crucifixion is seen in the centre of a cruciform golden gibbet. This figure is connected with the first figure of the first plate, and symbolises the analogy between the mundane or material work, represented by the leprous man on the gibbet, and the spiritual work represented by Jesus on the cross. The second and third figures are closely inter-related and represent the Virgin Mary, clad in blue, standing on a moon-crescent surrounded by a halo and having above Her head Jesus crucified against a blue lily. The first of these two figures shows the halo surrounding only the Virgin Mary's head, while in the second she is entirely surrounded by a halo which is adorned with twelve stars of which only ten are visible. These figures are dealt with at length in the text and represent the Opus Minor, capable of transmuting the base metals to silver, and the Opus Major, capable of transmuting to gold, respectively, (*i. Poisson*, pp. 93–94 ; O. Wirth, *Le Symbolisme Hermétique*, Paris, 1931, pp. 17, 56, 57, 59, 61, 123, 161).

The eleventh plate is undoubtedly the most striking of a series of highly unusual miniatures. It represents the Grand Hermetic Androgyne trampling underfoot the four elements of the materia prima. This figure must be considered in connection with plate No. 9. In this case the union of the two opposite natures appears to have been indissolubly effected. The right-hand, masculine, side of the figure, is clad in blue armour, heightened with silver (Jupiter-Moon) ; the left-hand side, feminine, wears a brown robe heightened with gold (Saturn-Sun). The right-hand wing is green heightened with gold (Venus-Sun) and the left-hand one, blue heightened with silver (Jupiter-Moon). This, therefore, will readily be seen to indicate complete intermingling and exchange of character and properties in the case of the two opposite principles ; a philosophic conception frequently met with in alchemical literature.

The figure stands in a position of triumphant combat ; the right-hand holds a sword, symbol of fire, and red (Mars) crown, symbol of destruction. The left hand holds the golden crown (Sun) of the Opus Major. The dragon of Mercury found in plate No. 9 is shown here strangely enlarged ; its two heads have been multiplied into four, portraying Lust, Deception, Fury and Hate. From the upper pair of these faces issue two serpentine extensions, terminating in diabolical faces and twined around the figure's legs. Here the Allegory shows the forces of Good having overcome those of evil, which, nevertheless continue to struggle.

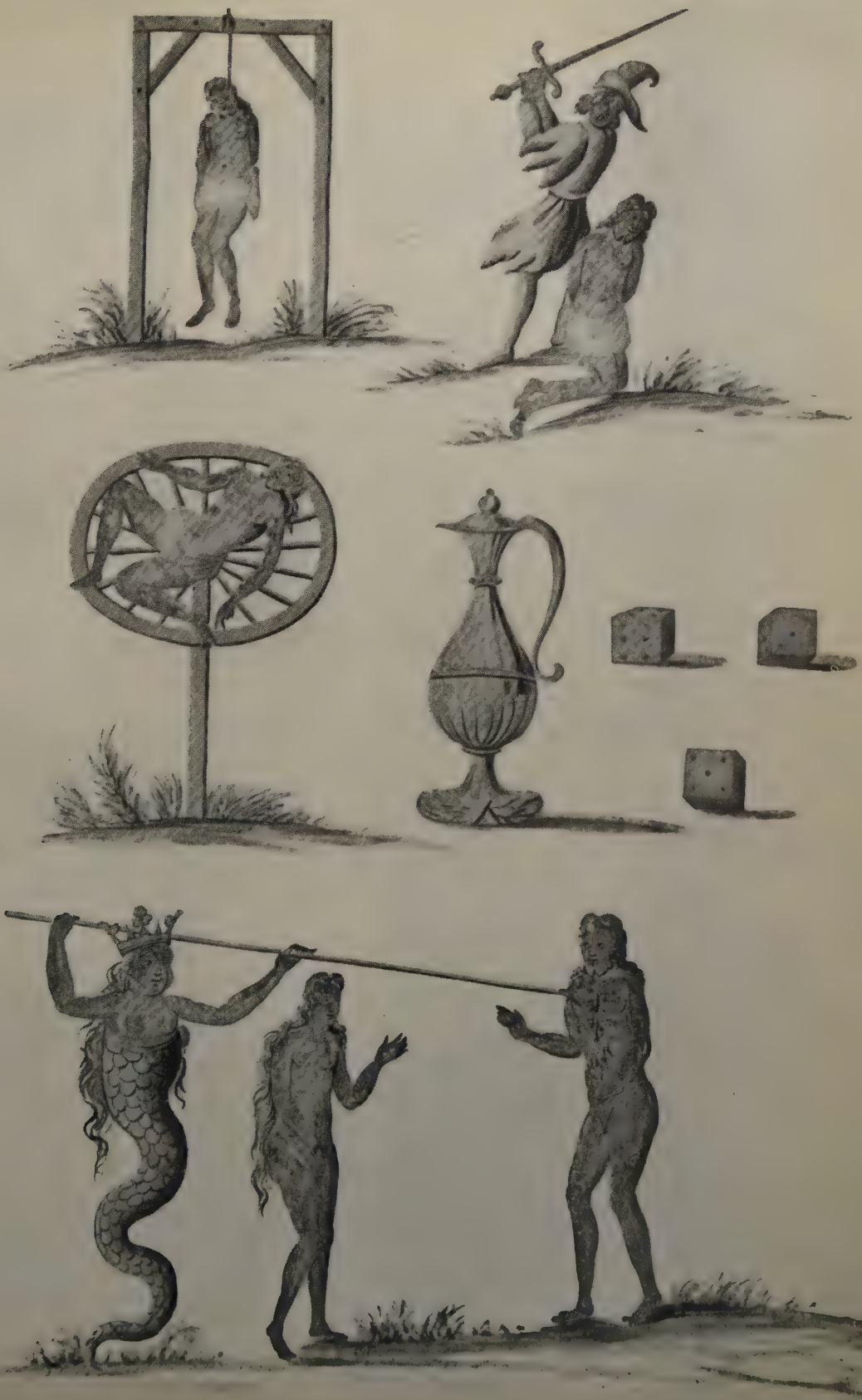
In the next, the twelfth plate, there are four distinct figures.

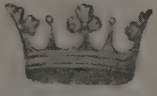
(1) An empty silver vessel, symbolic of the metallic nature of the materia which must be animated in order to ' éclairer les metaux imparfaits ' (*Pernety*, p. 255). (2) A blue triangle apex downwards and surrounded by a double fillet of gold. From the text we understand this to refer to ' saphir fixe ' and from Pernety (pp. 448 and 120) we find that this symbolises the ' eau mercurielle des Philosophes '. (3) Jesus, with a golden halo, sits in the centre of a lozenge holding a sword in His left hand and having a flowering branch issuing from His right shoulder. This branch is referred to in the text as ' le fleur Mercurius ', the sword, as usual, symbolises the fire. The lozenge surrounding Him is in four colours which, reading from the outside are black, red, yellow, green (Saturn, Mars, Sun, Venus). (4) The armorial device of the Virgin Mary has already been encountered in her coronation (plate 6). This representation of her device differs slightly from the previous one ; here the hands of the two Persons are not united but separate, indicating the duality of the principles, their complete and intimate union still leaving each separate and distinct from each other.

The thirteenth plate contains two subjects :—(1) The crucifixion. Jesus clad in red carries a golden cross and a little further on He is seen crucified on a golden gibbet, this being the same as that on which the leprous man hangs in plate 1, and to which Jesus is attached in plate 10. Jesus clad in a red robe symbolises the achievement of the Great Work, achievement of which can only be accomplished by the passing of the base metals through various ordeals, just as the Redemption of Sins was only achieved by Jesus passing through the ordeals of crucifixion. (2) The resurrection. Jesus, still clad in red and surrounded entirely by a golden halo and carrying a cruciform standard with a red pennant, has left His tomb and ascends to heaven. This represents the completion of the Great Work. In the text the pelican is found referred to as ' Sepulchrum Christi '.

The last illustration shows us the author of the book, clad in a brown habit of the Franciscan monk (or possibly St. Francis himself), receiving the Stigmata. This, of course, alludes to the close bonds which unite the Macrocosm and the Microcosm, but it is worthy of note that however closely these may be united, each still retains its own individuality[5].

[5] The Hon. Editor regrets that the title of the MS. is incorrectly printed at the head of the plates which follow. The correct title is that which is given as the title of the paper.





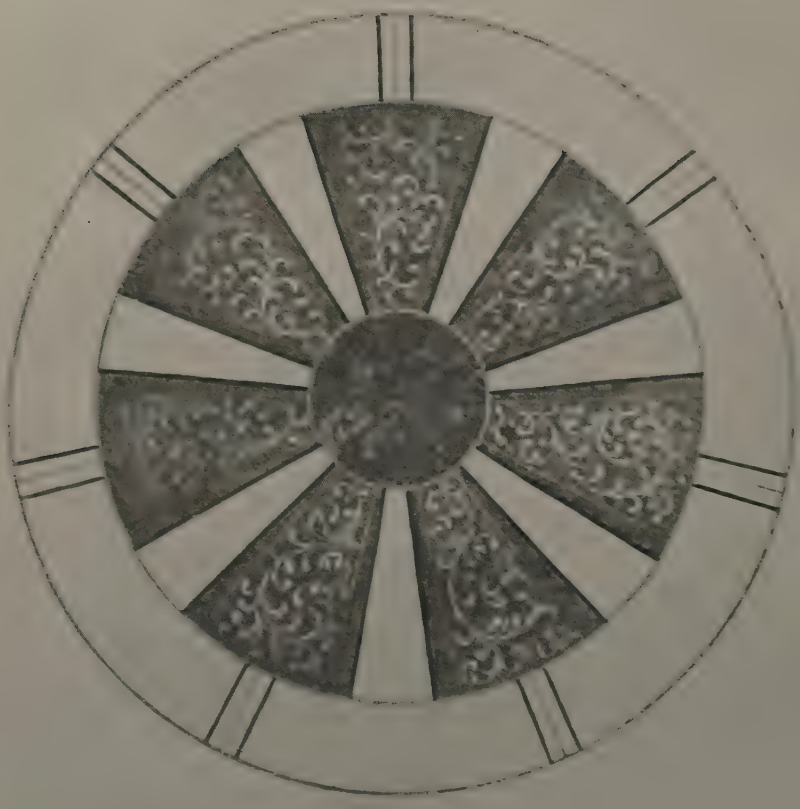
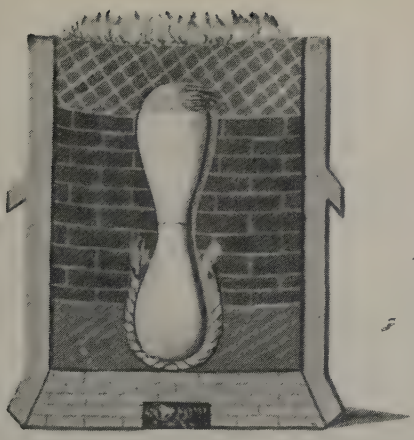
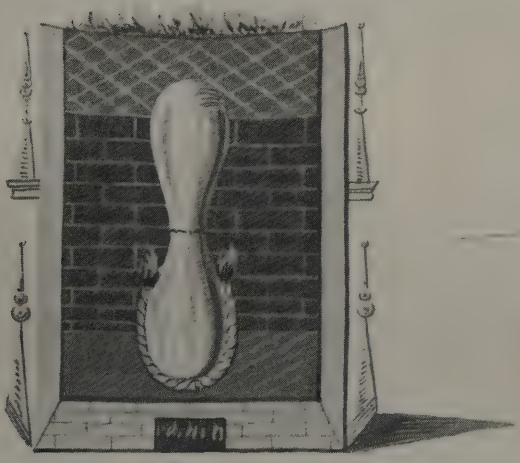
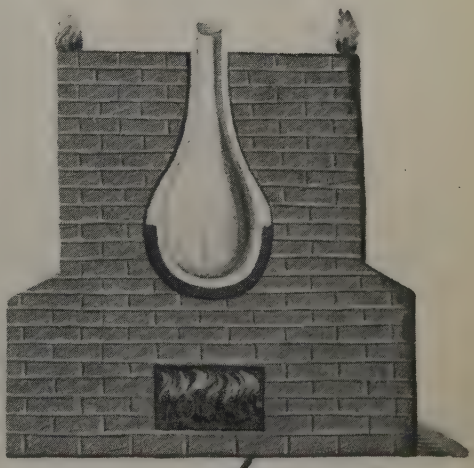


PLATE 5

PLATE 6







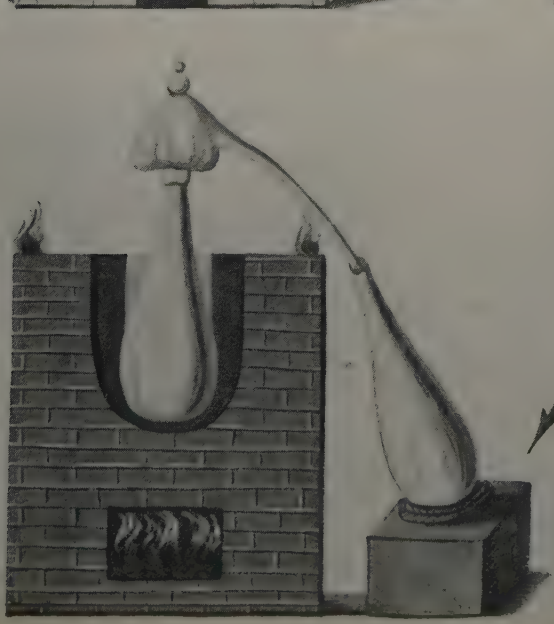


PLATE 7

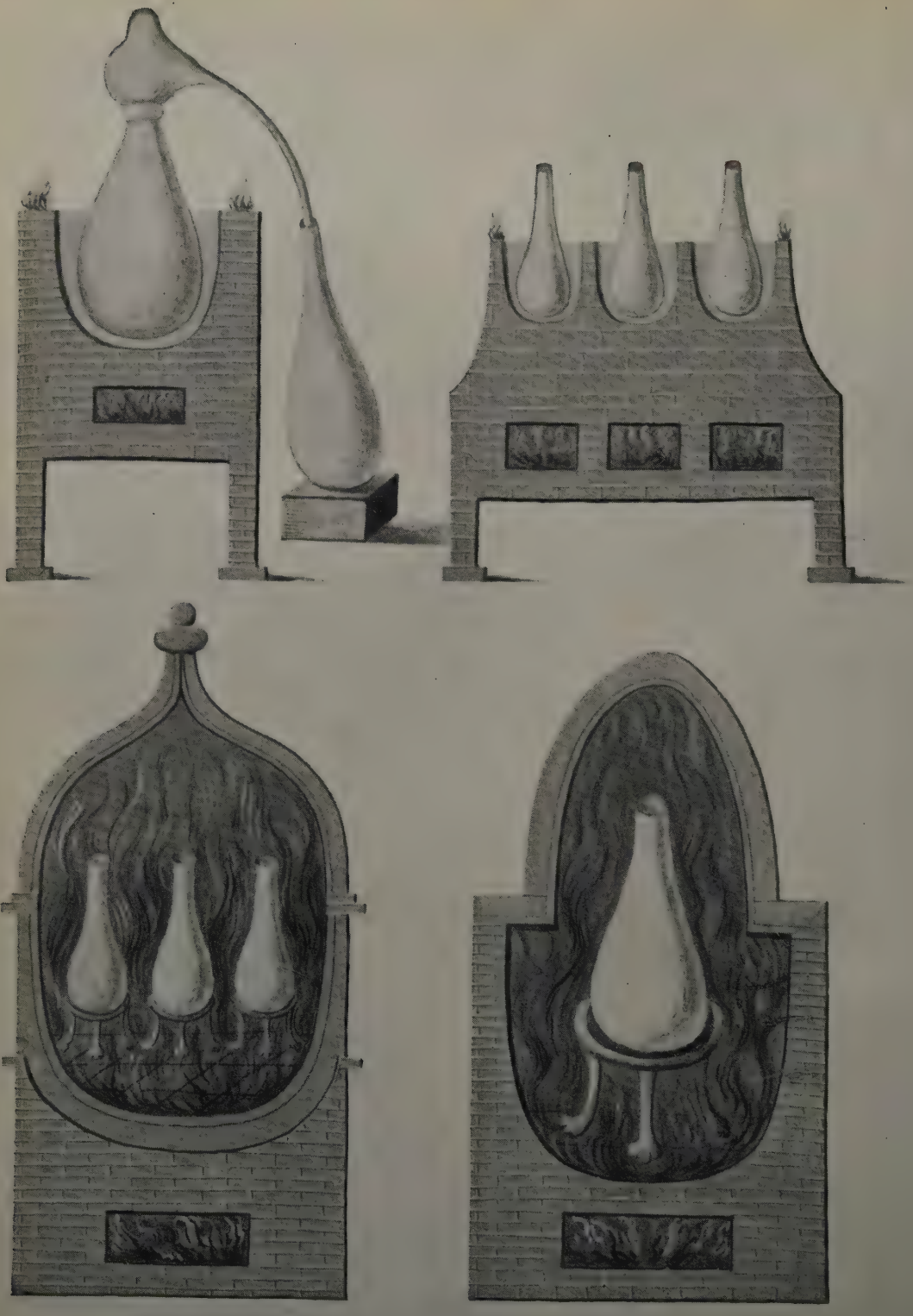


PLATE 8

PLATE 9

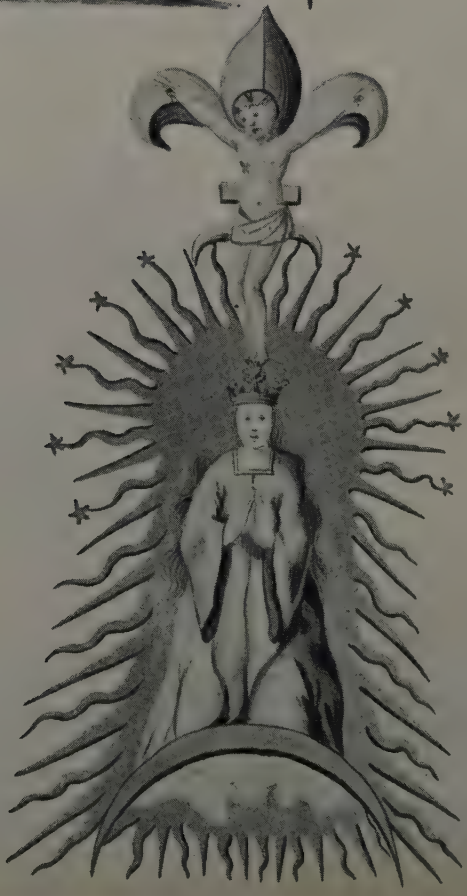


PLATE 10

PLATE 11

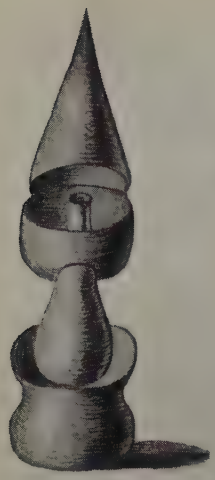


PLATE 12

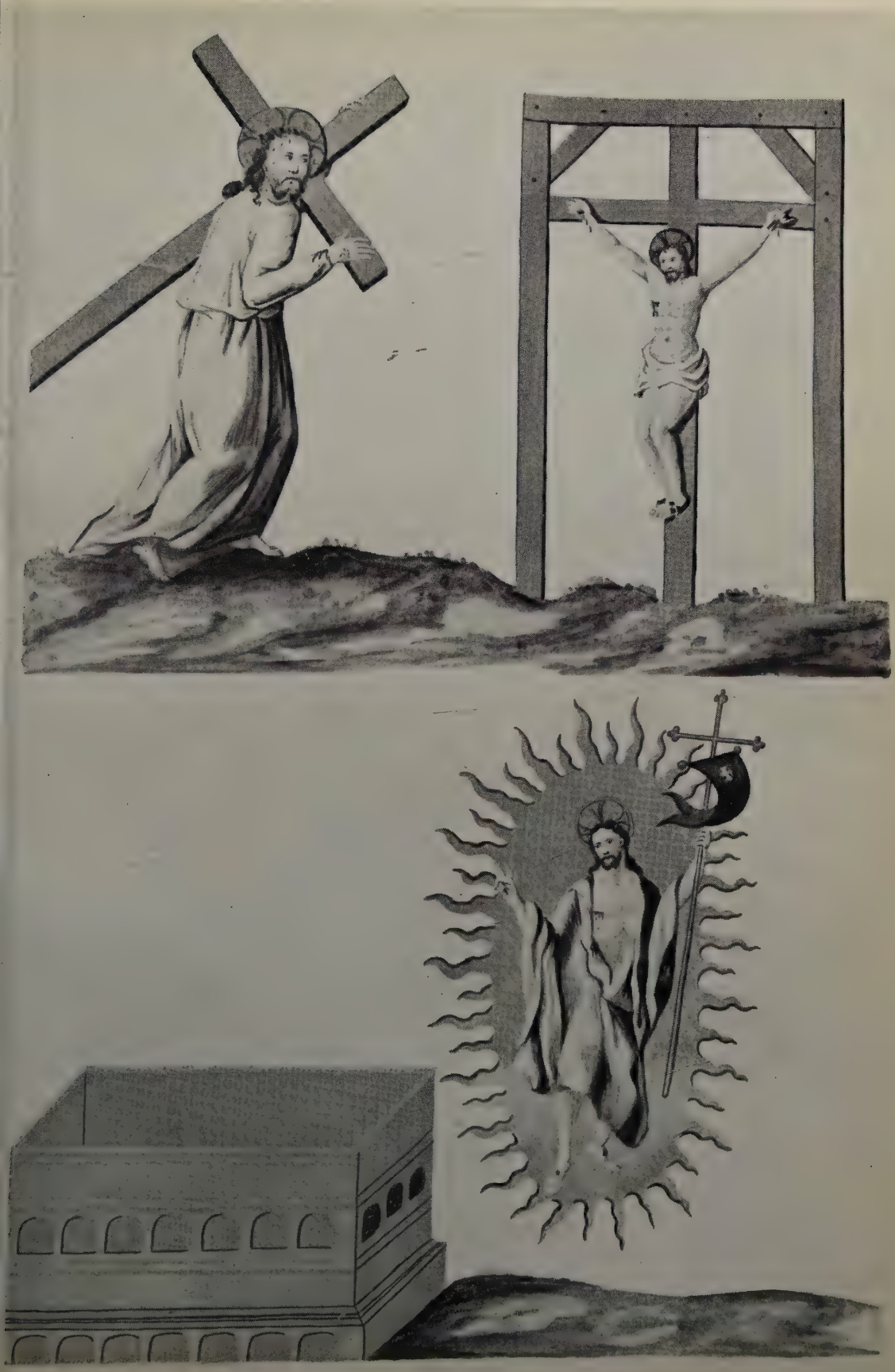


PLATE 13

PLATE 14

THE CHEMICAL WORK OF PARACELSUS[1].

By T. P. Sherlock.

(1) *The Paracelsan Revolution.*

Few figures in the History of Chemistry have been the object of more extensive research than has Paracelsus, and none has been the object of more violent controversy. Much of this controversy can be avoided by confining our attention to his contributions to chemistry, and by referring to his views on medicine and philosophy only so far as is necessary in order to throw light on his influence on the development of the former subject. It is, however, necessary to say something about his personality, for this perhaps went further than any other single element to explain his success, and that of the revolution which he brought about.

It is interesting to note the traits that he shares with his contemporary fellow-German, Luther. Both possessed a dynamic violence of character which manifested itself in an explosive and often coarse use of the vernacular, in a rich imagery, in a readiness to attack existing views and institutions, and, at times, in the forcible expression of their views by external dramatic action, whether by burning the works of Galen and Avicenna in the market place at Basle, or nailing the list of theses against indulgences to the church-door at Wittenberg. Both were innovators who sought to shatter long-established practices; by character and inclination more apt for demolition than for the less spectacular work of building up a coherent body of teaching that should replace what they had destroyed, and it is for this very reason that opponents have always been able to make great play with the inconsistencies which abound in their works. Both owe a large part of their success to the fact that each of them in his own sphere answered a real need of his day. A wiser man than Paracelsus, a greater experimenter, a more careful observer in the laboratory, might have passed unheard in that violent age, in which only the loud voice and the qualities of a showman could obtain a hearing for novelties.

If we accept the carefully documented views of Ernst Darmstaedter[2], we must hold that Paracelsus is not to be regarded as one who freed chemistry from the chains of alchemy, or as a modern experimenter, but that his real contribution to the progress of chemistry is in the new direction that he gave

[1] The manuscript of this paper formed a portion of a work, dealing with Andreas Libavius, which was left unfinished by reason of the author's untimely death. It has been edited by the Hon. Editor of this journal, who would wish here to record his sorrow at the death of a close friend and a promising historian of science.

[2] Ernst Darmstaedter, Arznei und Alchemie. Paracelsus-Studien. *Studien zur Geschichte des Medizin*, Leipzig, 1931.

to its activities in consequence of his whole philosophic outlook. This point of view, as developed by Darmstaedter, helps to make many of the writings of Paracelsus more intelligible than they would otherwise seem, though there remains a doubt as to whether he really had quite as systematised a philosophy as Darmstaedter attributes to him. For our present purpose, however, it is sufficient to isolate one point in that philosophy, which may briefly be expressed as the *unity of all things*.

(2) *The Philosophical background.*

In the history of philosophy the fifteenth and sixteenth centuries are a period of confusion during which long-accepted views were crumbling. The mediaeval passion for intellectual order had produced a synthesis which, however sound were its metaphysics, was premature in the absence of any adequate physics. Its destruction was brought about in these two centuries, not by any increase of man's knowledge of nature, nor through practice of experimental methods, but by the resurgence of even more ancient philosophies and a preference for beauty rather than for precision of formal logic. If the men of the renascence turned to Plato, it was to be delighted rather than instructed, and most of their interpretations of his philosophy show sterility of thought and ignorance of history. There reappear certain general features, which through the ages have been loosely grouped together as neo-Platonism. There is a tendency to pantheism, to a vision of all as in some way one, and as in some degree alive. Hierarchic orders, emanative theories and monophysite views manifest themselves as constituent notions in varying proportions. The taste for imagery such as that of light going forth, or of springs welling up, is indulged in at the expense of definition, so that it is often hard to reduce the teachings of an individual writer's to a coherent body of thought. These characteristics appear in the writings of Paracelsus, yet it would do less than justice to his extreme originality to dub him neo-Platonist. Darmstaedter perhaps errs in giving too systematic an interpretation to the ideas which are scattered throughout the works of Paracelsus, but the views that he has collected together [3] are of value in helping towards an understanding of these works, even in their chemical aspects.

The fundamental notion which underlies the thought of Paracelsus is that of the unity of all things, the manifestation by the ' world-whole ' of an organic, almost living interdependence of all the parts. This notion of unity links together many primitive ideas which find their place in the Paracelsan world-view. There is a unity of the ultimate raw material and the primitive power or force associated with it. There is a unity of heaven and earth, which is thought of partly in terms of the real or supposed influence which the sun, the stars and the planets, exert upon the life of plants, animals, and men and on

[3] Darmstaedter, *op. cit.* pp. 1–6.

medicines derived from these, and partly in terms of the repetition of pattern which gives rise to the notions of macrocosm and microcosm. The same influence makes him view Nature, in her operations that bring about life, death, sickness and health, as a kind of ' world-alchemist ' ; man in his function of preparer of remedies becomes the alchemist of nature, while within man dwells a further ' archeus ' or alchemist who works in the stomach, which is, as it were, his laboratory. The Paracelsan notions of health and sickness, and of healing, are a little difficult to grasp, for he seems to intend by them something more than mere qualities which are found in pre-existing things, and assigns to them the status of things existing in themselves. All come equally from God's hands, and the time of healing, which is His, depends therefore on a unity of heaven and earth, for the understanding of which a knowledge of astronomy is required. The healing art is, therefore, something God-like.

With the help of these general notions we can see why Paracelsus insists on the necessity of the four ' pillars ' of medicine, *i. e.* Astronomy, Philosophy, Alchemy and Virtue. The function of astronomy is as explained above and needs no further comment. Philosophy helps us to understand the unity and interrelation of the world-whole. The notion of ' virtue ' (*tugent*) is not so clear, but on the whole it is equivalent to the idea of ' goodness ', so that it may refer equally to the moral worth of a person, the potency of a medicine, or the nourishment of a food. The stress laid on the importance for medicine of alchemy, in the sense understood by Paracelsus, is perhaps the most fruitful contribution which he made to the development of chemistry, and must be examined more fully. Though these views run through all the medical writings, they are explained most fully in the *Paragranum.*

(3) *The Paracelsan conception of Alchemy in the Paragranum.*

The leading ideas of Paracelsus on the function of alchemy in medicine may be summarised thus :—

Sickness and health are controlled by astral influences. Health is restored and sickness driven out by the *arcana.* The work of these arcana is to restore a celestial harmony between an inner astrum in man and a heavenly astrum, and therefore they must, as it were, reach out to heaven ; hence they are ' volatile ' and incorporeal. The function of alchemy is not to make gold and silver but to prepare the arcana [4].

The meaning of the term alchemy is further expanded to include any process whereby natural products are made fit for some new end, and so to cover such diverse operations as the smelting and working of iron, the baking of bread, or the digestion of food in the stomach under the control of the inner alchemist or archeus.

[4] It should be noted that the views given above are not peculiar to Paracelsus, but form part of a well-known mediaeval theory of chemical medicine, which is most clearly set out in texts concerned with the quintessence and attributed to Lull and Rupescissa.

Physicians, he tells us, must know about the stars in order to know the causes of sickness, and about alchemy in order to know about the preparation of the arcana. In addition to these arcana there are certain subsidiary remedies, such as quintessences, magisteries, and the like, which are to be included in the art.

The following passage from the Paragranum (2nd version, *Sud.*[5] VIII, p. 185) makes the matter very clear :—

> ' It is not the physician that controls and directs, but heaven, by the stars ; and therefore the medicine must be brought into an airy form (*in luft*) in such a manner that it may be directed by the stars. For what stone is lifted up by the stars ? None save the ' volatile '. Hence many have looked for the *quintum esse* in alchemy which is nothing else but that thus the four elements are taken away from the arcana, and what remains afterwards is the arcanum. This arcanum furthermore is a ' chaos ', and it is possible to carry it to the stars like a feather before the wind. Now the preparation of the medicine should be done in this way. The four elements are taken away from the arcana, and then it should be known what astrum is in this particular arcanum, and what is the astrum of this particular disease, and what astrum is in the medicine against the disease. This is where the directing comes in. If you give a medicine, the stomach has to prepare it, and it is the alchemist. If it is possible for the stomach so to manage it that the astra accept (each other ?), it (the medicine) is directed ; if not it remains in the stomach and goes out through the stool. For what is more noble in a doctor than a knowledge of the concordance of both astra,—for there lies the basis of all diseases ? Now alchemy is the outer stomach which prepares for the stars its own. The purpose of alchemy is not, as it is said, to make gold and silver, but in this instance to make arcana and direct them against diseases ; as this is the outcome, so it is also the basis. For all these things conform to the instruction and test of nature. Hence nature and man, in health and sickness, need to be joined together, and to be brought into mutual agreement. This is the way to heal and restore to health. All this shall be achieved by alchemy, without which these things cannot be done '.

This passage gives in its most concise form the general teaching of Paracelsus on the astra, the arcana, and alchemy. Sickness is not to be cured by a direct control brought about by the doctor, his function is to restore the ' concordance of both astra ', to join together nature and man and to bring them into mutual agreement. His work is almost passive, and its result is to make things to conform to the instruction and test of nature. The medium he uses for this is an arcanum, selecting his arcanum according to what astrum is involved in the disease. As this arcanum has to be ' lifted up to the stars ', it must be in an airy or, as it were, spiritual, form so that it may be directed by the

[5] Theophrast von Hohenheim. gen. Paracelsus. *Samtliche Werke*. Herausgegeben von Karl Sudhoff. Berlin. Vols. I–XIV, 1923–33. This work will be referred to throughout as *Sud.*

stars, *i. e.* it must be, as it were, ' winged ' (volatile). The same notion is expressed by saying that the arcanum is a ' chaos ', as this word is used by Paracelsus almost in the sense of the modern word gas (see below, p. 000) hence it can be carried to the stars. These repetitions make it quite clear that this property of establishing contact or relation with the stars is the fundamental function of the arcana. Although he says elsewhere (see p. 000) that the arcana and the quintessences are to be distinguished, both here and elsewhere he often uses the terms as almost equivalent. Its essential nature is obviously considered as incorporeal or spiritual, as it is something which is left over when the four elements, the constituents of all corporeal things, have been taken away ; and to that extent it resembles the idea commonly held about the quintessences as related to the fifth essence or element which constituted the ether of the firmament, though this use of the word would have sadly confused Aristotle. Even when the right medicine has been given there remains the function of the stomach, which by its inner alchemy has so to manage it that the astra are by some means brought into concordance, and this when successful ensures that the medicine is ' directed ', a word to which Paracelsus clearly attaches a special meaning. If the stomach achieves an inner alchemy, so conversely, alchemy is an outer stomach ' which prepares for the stars its own '. Hence he insists that the ancient idea that alchemy exists to make silver and gold must be set aside, its function is the nobler one of preparing the arcana which shall be ' directed ' against disease. In conclusion he once more insists that without alchemy the healing art cannot come to anything. A further quotation from the *Paragranum* (2nd version, *Sud.* VIII, p. 124) establishes this point.

> Many have said of alchemy that it is concerned with making silver and gold, but that is not our purpose here, which is only concerned with preparation and with what virtue and power (*tugent und kreft*) are in medicine, which has no body. [After an abusive aside against pharmacists, physicians, and barbers, he then continues :] Finally my idea of alchemy is that it is the foundation and pillar of medicine ; and in this way the things I previously said about philosophy and alchemy (astronomy ?) are to be understood, and so no doctor must be without the art, otherwise he will be like a mixer of pig-wash trying to be a chef. Hence you must understand that nature will have alchemy, and wants the doctor to understand it and to be very skilful and fully expert in it, and not to be a mere boiler of stew.

This passage repudiates again the ancient idea of alchemy as making gold and silver, and insists once more that it is a pillar and foundation of the healing art. The odd phrase ' which has no body ' (*die kein leib hab*), seems to refer to the incorporeal nature of the medicine, or rather to the arcanum in it, as of course the actual medicine is obviously something physical, which has a body. There occurs the oft-repeated insistence on ' nature ', which is at least personified, and probably thought of as in some way personal. It seems as

if the words ' philosophy and alchemy ' should be ' philosophy and astronomy ' as he has just been speaking about these two, but Sudhoff in critical notes in the text makes no mention of any such alternative reading, and does not seem to have thought the matter worthy of any remark. It is difficult to translate the Paracelsan abuse—there is no English equivalent for ' seukoch ' or ' fürstenkoch ', and stew is a somewhat inadequate translation of ' suppenwust '.

Another passage from the *Paragranum* (1st version, *Sud.* VIII, p. 40), throws light on the relation of alchemy and medicine.

> The rôle of the doctor arises in this way. There is the ' seed ', the ' materia ', and this must be prepared. The preparation is done by alchemy which teaches the cooking and making, as nature intends them to be for the benefit of man. For instance nature has much power in hypericon, and corresponding to each power there is a special preparation. This is the order nature gives to alchemy : prepare it thus for this disease, and thus for that disease. The doctor then sheds light on the matter, for he knows the cause, and with it the manner of cooking and preparing. But what light do you shed, you doctors of Montpellier, Vienna and Leipzig ? About as much light as the sheen of a spanish fly in a dysentery stool.

This passage emphasises the personal interest that the doctor must take in the preparation of medicine by alchemy. The method of preparation is not something fixed, like the text-book preparation of some well-defined chemical compound, and it is important to grasp that Paracelsus does not seem to have envisaged his remedies in the light of chemicotherapic ideas, even though in fact his practise may have led to the same results as if he had done so. The method of preparation of the medicine is to be varied according to the disease, and as will be seen below (p. 58) Paracelsus seems to have attached almost more importance to the process of preparation than to the actual nature of the substance prepared.

There are several passages which illustrate how definite is the teaching of Paracelsus that sickness is not to be explained in material terms, nor to be cured by material means.

> The arcana are all medicines, and the medicines are arcana, and the arcana are ' volatilia ' (Paragranum, 2nd version, *Sud.* VIII, p. 186).
>
> All the arcana are so constituted that they achieve their work without ' materia ' or ' corpora '. For the causes of sickness are not ' corpora ', wherefore spirit (*geist*) must be used against spirit (*Sud.* VIII, p. 178).
>
> ' Contraria a contrariis curantur ', that is heat dispels cold ; that is false and never has been the case in medicine, but rather arcanum and sickness, they are the contraria. Arcanum is health, and sickness is adverse to health, these two repel each other, etc. (*Sud.* VIII, p. 88–9).

The new version of the ancient doctrine of curing by contraries is not so much an adaptation of a venerable doctrine as a complete revolution in medical theory, quite unacceptable to almost all of his contemporaries. None of these passages, however, make it clear how a material medicine was the vehicle

for the incorporeal arcanum, or how the arcanum was corporeal and spiritual at the same time, but a clue is to be found in the word 'volatile', which suggests that they are thought of as substances which readily pass into the vaporous condition and so become 'spirits', and then are no longer bodies, for the notion of vapours and gases as merely other forms of substances which under different conditions of temperature would be liquids and solids was still in the future, and even the simpler notion of melting as a merely physical change was not yet recognised.

14 *Paracelsus' conception of Alchemy in the Labyrinthus Medicorum Errantium and the Paramirum.*

The *Labyrinthus Medicorum Errantium* is dated by Sudhoff as 1537/1538, with 1553 as the date of the first published edition, and is a work of unquestioned authenticity. Chapter V (*Sud.* XI, p. 186) is headed 'The book of Alchemy, without which no one can be a physician'. There is a good deal of repetition in it, but the following are the main ideas.

1. God has made all things, and these have a natural end to which they will come by the power of nature within them.

> 'God has made every thing; something from nothing. This something is a seed; the seed gives the end of its predestination and of its office' (*Sud.* XI, p. 187).

This notion of 'predestination' is dealt with in connection with the Archidoxis. (see p. 45).

2. God has assigned to man the function of transforming things from this natural or raw state to a condition fit for man's use. For example the tree develops to its own end, i. e. to be a fully-developed tree, but not to the stage of being charcoal, for that is the work of man. So also God gives iron, but it must be worked up by the smelter and the smith.

3. This all-embracing process of transforming raw materials into finished products is what Paracelsus means by alchemy, or at least what he had come to mean by it in 1537. It is so entirely novel a use of the word that it is well to consider the examples he gives. Referring to the process of obtaining iron in useful form he says:—

> 'This is alchemy, and the smelter is called 'vulcanus'. What the fire does is alchemy, also what is done in baking and cooking, and what is done by the stoker (*stubenheizer*)' (*Sud.* XI, p. 187).

He gives examples of the outer alchemy which is involved in milling flour and baking bread, and the inner alchemy of the microcosm which receives this bread as prime matter in the mouth and converts it into second matter in the stomach and then goes on to build it up into flesh and blood which is now ultimate matter. When, however, there is a decline of health, then this living matter is the first matter of a new process and death is the ultimate matter

and this is a new alchemy (*Sud.* XI, p. 188). Here, not only has alchemy received a new meaning which is surely peculiar to Paracelsus, but the terms ' first matter ' and ' ultimate matter ' are used in a sense that is quite different from current usage of the day, and seem to have a meaning dependent on the particular process under consideration, so that what is ultimate matter (*i. e.* the final product) in one process becomes the first matter or starting point for a new process. It is difficult to decide which is the more confusing in Paracelsus, his gift for inventing entirely new terms, or his habit of using well-known words in an entirely new meaning. Feeling at the end of his chapter that he may not have made his point quite clear, he goes back once more to the example of bread, which is indeed given by God, but only comes to us in a useful form after the work of the farmer, the miller and the baker, and from this example draws once more the conclusion that medicine needs its alchemy in order to have its remedies in a useful form, so that it conforms with the inner vulcanus.

A very wide connotation of the term ' alchemy ' is employed by him when he lays it down that the work of alchemy is to separate the pure from the impure. After the passage quoted above, declaring that alchemy is what is done by the baker, the cook and the man who lights and tends the fires, he goes on immediately to apply this notion to medicine :—

> ' Thus it is also with medicine, which is made by God, but is not made ready prepared in its final form, instead it is mixed with dross. As has been explained for iron, so it is also with medicine. That which the eye sees in herbs or minerals or trees is not in medicine. It sees only the dross, but inwardly under the dross lies the medicine. Now, to begin with, the dross must be taken away, and then the medicine is there. That is alchemy, and the work of the vulcanus ; there he is an apothecary and a maker of medicine ' (*Sud.* XI, p. 187).

The repeated use of the analogy of iron and of the term ' schlacke ' meaning slag or dross, derived from the vocabulary of smelting, is of special interest as showing that to Paracelsus, generally regarded as the founder of the view that chemistry is concerned with the making of medicines, the artificial separation of medicine and metallurgy, which Libavius opposed so vigorously, would not have been congenial.

Paracelsus has indeed given to the word ' alchemy ' very much the scope that has since been given to the word chemistry, and we may well suppose that the notion of the unity of chemistry, which Libavius so strongly upheld, was in some part derived by him from his knowledge of the works of Paracelsus. The view of alchemy as separating the pure from the impure in the sense of the separation of metals from their ores may seem to differ from the view, explained above, of its function being to prepare arcana, but as the latter were to be prepared by separating the gross from the subtle the two views are obviously not incompatible but rather complementary.

5. The word *vulcanus*, which appears so often in the fifth chapter of the *Labyrinthus*, seems to have a variety of analogous meanings, *e. g.* ' Alchemy is an art, vulcanus is the worker in it, and where he works, there the art is powerful ' (*Sud.* XI, p. 186). ' Vulcanus ' here may be the actual human alchemist, but more probably is thought of as some ' spirit of alchemy '. When referring to smelting of iron he says ' this is alchemy, and the smelter is the vulcanus ' (*Sud.* XI, p. 187), which clearly refers to the actual metal-worker. The work of separating medicine from the dross is also alchemy ; *e. g.*

> ' . . . and the work of the vulcanus, there he is an apothecary and a maker of medicine ' (*Sud.* XI, p. 188).

Further the ' archeus ' is the ' inner vulcanus ' ; the archeus and the vulcanus separate things from each other (*Sud.* XI, p. 188). Finally when referring to the part played by the farmer, the miller, and the baker in making bread, he calls them the three vulcani (*Sud.* XI, p. 190.) This wide use of the word vulcanus corresponds to the wide use he makes of the word alchemy, as all that the vulcanus does is alchemy. With the aid of these observations the central passage of this chapter can be profitably examined.

> This is the way that nature proceeds with us in God's creatures, and as follows from what I have said before, nothing is fully made, *i. e.* nothing is made in the form of ultimate matter. Instead all things are made as prime matter and subsequently the vulcanus goes over it and makes it into ultimate matter through the art of alchemy. The archeus, the inner vulcanus, proceeds in the same way, for he knows how to circulate and prepare according to the pieces and the distribution, as the art itself does with sublimation, distillation, reverberation, etc. For all these arts are in men just as they are in the outer alchemy, which is a figure of them. Thus the vulcanus and the archeus separate from each other. That is alchemy, which brings to its end that which has not come to its end, which extracts lead from its ore and works it up to lead, that is the task of alchemy. Thus there are alchemists of the metals, and likewise alchemists who treat minerals, who make antimony from antimony, sulphur from sulphur, vitriolum from vitriolum, and salt into salt. Learn thus to recognise what alchemy is, that it alone is that which prepares the impure through fire and makes it pure (*Sud.* XI. pp. 188–9).

This reiterates the references to the natural state in which God has left things, and indicates again that it is the work of alchemy to bring it to a finished condition, or ultimate matter, in the sense explained above. It elaborates the comparison between the work of the outer alchemy and the processes of the stomach, speaking of these latter in terms of the alchemical processes of circulation and preparation, and emphasising this by adding the processes which are peculiar to the outer alchemy, namely, sublimation, distillation and reverberation. The phrase ' according to the pieces and the distribution ' is simply a direct translation of the original ' nach den stücken und austeilung ', the meaning of which is obscure. The Latin translation in the Huser Edition, cited below, ' pro cujus rei natura et differentia ' may

represent the meaning, and is certainly a probable interpretation. The next sentence repeats the parallel between the outer and inner alchemy, which suggests that the following sentence cannot be taken as it stands in the German ; ' Also schieden sich von einander der vulcanus und der archeus '. This the Latin very naturally translates as ' Et in hoc differunt Vulcanus et Archeus '. This may mean that it is precisely in the fact that the archeus is within and the vulcanus without, that they differ, but the whole sequence of thought is emphasising the resemblances between them, not the differences, and the latin text is scarcely to be taken as a guide as in the next sentence it omits the important word ' not '. It seems better to take the view that the phrase ' schieden von einander ', so constantly used by Paracelsus, means the splitting up process which is characteristic of alchemy, that here the ' sich ' is either to be omitted, or taken to refer to the parts into which things are split up. This use may be illustrated from a passage occurring in the same book (*Sud.* XI, p. 212) where the sentence occurs : ' Alein brauch alchimiam, das da scheidet von einander '. (Use only alchemy, which separates things from one another.) Finally to make his meaning clear Paracelsus gives examples from familiar metallurgical and chemical processes, and underlines the lesson that *alchemy prepares the pure from the impure through fire.*

The lesson of the fifth chapter of the *Labyrinthus* is, then, that God has left to man the task of completing the work his Maker has begun ; alchemy in its widest sense is this work of completion or preparation, but in certain passages (as where alchemy is characterised as ' that without which no physician can be a physician ') it means more particularly the process of separating the pure from the impure.

These views which Paracelsus thus fully expressed in 1537 are no more than the expansion of views which he already held in 1520. The *Volumen Paramirum de Medica Industria*, which Sudhoff dates as about 1520, contains a number of references to the alchemist of nature and the inner alchemist (*Sud.* Abt. I, B. I, pp. 191–194). The inner alchemist of the ostrich can ' separate ' iron, and that of the salamander can deal with fire for its food. The alchemist in our stomach separates the good from the bad and turns this good to a ' tincture ', which word is taken from the vocabulary of the alchemists. God gives us this alchemist, and also gives to the ' alchemist of nature ' to have in himself the knowledge of separation and use of the good, as befits a prince. Alchemy in this sense is founded by God, and indeed God is the supreme doctor, ' Got der erste artz sein sol ' (*Sud.* Abt. I, B, p. 229).

The same book contains the teaching whereby certain organs of the body are associated with certain heavenly bodies (*Ibid.* p. 208) the heart with the sun, the brain with the moon, the gall with Mars, the kidneys with Venus, the lungs with Mercury, and the liver with Jupiter, but does not contain anything to connect these planets with the corresponding metals, which might have seemed an obvious line of development.

(5) *The Archidoxis.*

From the chemical point of view the most important single work of Paracelsus is the *Archidoxis*. Sudhoff assigns its origin to the years 1525–6 and regards its first publication in 1569 as a quite special event in the development of the literature of Paracelsus (*Sud.* III, p. 16) describing the work as his *Erzlehre* and *Grundlehre*. As a text-book giving the foundations of the chemical theory of Paracelsus it is obviously worthy of detailed study, and is of further importance as providing the clue to the system of classification which Libavius adopted in much of his famous work *Alchemia* (1597). A close examination of the *Archidoxis* may suffice to give as coherent a view of the chemistry of Paracelsus as its nature permits. There are at least two English translations [6] of the Archidoxis, which are helpful in giving the general drift of the book, but are not to be relied on in detail. According to Sudhoff the Latin translation of Adam Schroter, made from the original text, is clear and good, but unfortunately was not available to the author of this paper [7]. The Latin translation in the *Opera Omnia* [8] of 1658 has here been used to throw light on the original German.

(6) *The Prologue of the Archidoxis.*

The first book of the Archidoxis is the Prologue (*Sud.* III, p. 93), and deals with the microcosm, or inner organisation of man. It contains, as usual, a mixture of philosophy, theology and medical theory, interspersed with attacks on those who differ from the author in any of these branches of knowledge. His positive teaching begins with an emphasis on the need for the worker in the art to understand the mysteries of nature, which are imprisoned in bodies, just as fire is impeded in green wood, which cannot burn because of its moisture. The art must *separate* the mysteries of nature from these impediments, and this art of separation is to the art of the apothecary (*kunst aromatariorum*) as a light in the darkness. This double use of the word ' mystery ', as meaning on the one hand something which can be the object of knowledge in the mind, and, on the other hand, something which is imagined as fettered in bodies

[6] (*a*) Paracelsus his Archidoxes. Together with his books of Renovation and Restauration . . . Englished by J. H. Oxon. Lond. 1661.

(*b*) The hermetic and alchemical writings of Aureolus Philippus Theophrastus Bombas of Hohenheim, called Paracelsus the Great . . . by A. E. Waite, London, 1894.

[7] This is an extremely rare book and is not in the Bodleian or B.M. libraries. According to Graesse's *Trésor de Livres Rares et Précieux* it was published at Cracow and bears no date.

[8] Aur, Philip. Theophr. Paracelsi Bombast ab Hohenheim . . . opera omnia medico-chemica-chirurgica . . . 3 vol., Geneva, 1658. The Editor has also made reference to the Huser Edition of 1589. Erster (— Vierdter) Theil der Bücher und Schrifften des edlen . . . Philippi Theophrasti Bombast von Hohenheim . . . jetzt auffs new auss den originalien und Theophrasti eigner Handschrifft . . . an Tag geben : dürch Iohannem Huserum, 4 Tl, Basel, 1589/99.

and capable of being freed by the practice of the art of separation, is quite natural to Paracelsus, who with many neo-Platonists, does not draw a sharp line of demarcation between the world of external reality, and the world of ideas, but gives to the former a more spiritual character than would a nineteenth century materialistic scientist, and to the latter a degree of independent existence quite natural to the followers of Plato. Unless this fundamental philosophic outlook is borne in mind, what is at best confused and confusing becomes incoherent and incomprehensible. This is notable where Paracelsus goes on to treat of the basis of our knowledge of these mysteries, which seems to be mainly religious. This is less surprising when he explains that many of the mysteries themselves are religious, being concerned with God, the 'Eternal Good', virtue, and much else besides medicine. Hence the source of this knowledge is faith and not earthly reason. Clearly he had somewhere an experimental basis for his medical and chemical practice, but it is hard to find an unambiguous reference to this in his own writings where he deals with the basis on which he rests his science. In this chapter he says (*Sud.* III, p. 95): 'We should investigate the mysteries of nature in which the end shows the ground of truth'. This may mean that the experimental outcome of his investigations will establish their truth, but this view is somewhat obscured by the remainder of the sentence in which he exhorts us to seek these mysteries which not only give us the foundations, but also fill man with the mysteries of God and the highest charity. Later on, however, he says more explicitly that to this somewhat mystic basis we must add experience, *i. e.* what he has gathered with his own eyes: '*aus disem grunt nemen wir die medicin herfür und nach der experienz, das wir entlich wissen und sehen, das also ist, mit unsern augen*'. It is unfortunate that in this very same chapter occurs the statement that '*we have seen* a man live for six months without eating being sustained by a clod of earth laid on his stomach, and replaced by a fresh clod when dry'. It is not necessary to lay much stress on this passage, but it serves to illustrate the difficulty of sorting out fact from fancy in the works of Paracelsus.

This mystical element in his writings has been variously interpreted according to the prejudices of the commentator. Some have seen in his religious references an attempt to secure approval from powerful ecclesiastical influences, but this seems more than a little far-fetched, as in view of the acute state of religious controversy of the day it was much more likely to arouse hostility. Others see in it the outcome of a mind saturated with a religious vitalism, a biologically lit-up view of nature, the outpourings of a mind drunk with 'nature-enthusiasm', one in contact with things and not empty words or abstract speculations, who learned from nature and not from reason, one to whom 'the practise of chemical therapy and the insight into the chemico-dynamic workings were of value rather as a mystical ecstasy or an occult meditation'. Whatever view we take, it is worthy of notice that the practice

of occult naturalism and a tendency towards pantheism are characteristics of the naturalists of the Renaissance period. They may only be slight, as in the works of Nicholas of Cusa or Leonardo da Vinci, or very considerable as in those of Giordano Bruno. To that extent Paracelsus is a product of the tendencies of his age.

To return to the views of Paracelsus on the Microcosm, he says elsewhere ' Man is a microcosm and so he must have in him the four elements '. Here he is at pains to point out that this microcosm must be governed by medicine as a horse is led about by a bridle. To make this more clear he discusses the part played by the five senses, the mobility of the body, and the way in which what comes into the body, whether by the mouth or through the skin, is distributed inside the body. It is in connection with this notion of moisture being absorbed through the skin that he tells of the cows in the alps who do not drink during the whole of the summer, of the man who lived for six months through the influence of a clod of earth, and similar alleged phenomena. He concludes by undertaking to collect the fruits of his experience into nine books, but tells us he will refrain from writing the tenth book, dealing with their application, ' because of idiots ' who would abuse this knowledge.

(7) *Practical operations described in the Archidoxis. (a) Separation of the Elements.*

Throughout the Archidoxis the generally received teaching concerning the four elements is taken for granted, and there is no mention of the Paracelsan doctrine of the three principles. Characteristically, however, Paracelsus adds a fresh concept, that of ' predestination '. The underlying idea is that in substances consisting of the four elements, one element is predominant, and, so to speak, masters the other three. That any one element is predominant in any given substance is due to fact that it is predestined to this end. In the process of digestion and fermentation by which the predestination is realised the strongest element overcomes and subjects the other three to itself, so that these three cannot attain their own proper perfection, and are in relation to the perfect element as a fungus in a piece of sound timber (*gleich wie ein moder in einen holz*). It is this predominance of one and the feeble condition of the others that enables them all to co-exist. With this predominance of one element is associated the predominance of one complexion. Furthermore, this predominant element is the quintessence. Hence also the predominant complexion (*e. g.* heat, as in nettles) is associated with a similar quintessence, and this fact furnishes the basis on which quintessences are selected for various purposes.

Before, however, going on in subsequent books to deal with quintessences and the like, Paracelsus deals with the separation of the four elements themselves, and first of all he makes an interesting distinction between extracting the three elements from the ' Pure Elements ' namely ' burning fire, invisible air,

true earth, and natural water' and extracting them from bodies containing all four, though as previously pointed out only one will be predominant. It is interesting to see what he considered as 'pure elements', and presumably he only talks of extracting 'three', because the fourth is there already. He adds that when they have been separated in this way they cannot be further broken up (*so mögen sie weiter nimer* (or *nimmehr*) *gebrocken werden*), *i. e.* the complexion cannot be further altered. The sentence is one of peculiar difficulty to translate as a whole, but this single clause seems clear enough, and perhaps it is not too much to see in it some glimmering of the concept of an element as something which cannot be further resolved into constituents differing one from another. The passage seems to be of sufficient importance to be quoted in the original German.

> Also wird jetz not sein, zu verstehen, wie in der separation zu scheiden die corporalischen elementen von einander in allen dingen, practik und kunst sol angriffen werden. dan irer zwo seind. eine aus den lauten elementen drei daraus zu bringen, als aus brinnendem feur und aus dem unsichtbarn luft, und rechtem ertrich, desgleichen aus dem naturalichen wasser, die kein zugemessigen ursprung haben wie die vorbemelten. die ander ist von denen, in denen die vier seind, wie gemeldet ist, mit der underscheit, welche am meristen (meisten) feur gibt, welche wasser, welch ertrich, welche luft, und mit der form in vergleichen der elementen, wesentlich elementen, und so sie also geschiden seind, so mögen sie weiter nimer (nimmehr) gebrochen (gepracht) werden, also das sie zerstöret wurden aus den complexen. (*Sud.* III, p. 105.) (Alternative readings from other texts are given in brackets.)

He next makes a special note about Air, which at the moment of separation ascends upwards like a wind and takes some of the other elements with it, as for example when the essential element of air is separated from water, as happens when it boils, taking with it the lighter substance of the water. Here clearly he thinks of boiling in a way very different from our modern notions and presumably would hold that if all the water were boiled away, this would mean that all of it had been separated in the form of essential element of air. He further adds that it is to be noted that no element can exist without air, though the remainder can exist without each other, for which reason he will not undertake the separation of the air, for it is in the other three as life in the body, and when it is separated from the body all is lost. This animistic interpretation of the nature and role of air is possibly an echo of the ancient doctrine of the 'pneuma' which is drawn in from the general world-soul in the act of respiration, and which is the basic principle of life in the physiology of Galen. It is the application of chemistry to the whole world which is peculiar to Paracelsus. It accords well, however, with the doctrine of the 'arcana', in which the method of preparation is chemical but the result is quasi-spiritual. This setting aside of air as outside the scheme of separations, may afford some clue to its omission in the doctrine of the three principles.

Paracelsus then proceeds to give methods for the separation of the elements out of the metals. After a preliminary remark on the necessity of good apparatus, diligent work, solid experience of the art and manual dexterity, he begins the chemistry of the art of separation, and the practical details that he gives enable us in some measure to assess his chemical achievement.

> First of all make an aqua fortis thus : Take equal parts of alum, vitriol and salt-nitre. Distil to a strong aqua fortis. Pour this back on to the part left behind and redistil it in a glass cucurbit. In this aqua fortis purify a silver, and then dissolve therein a salmiax. After this has been done take the metal in a laminated form and dissolve it therein to a water. When this is done separate it from it in a water bath, and pour it over again till at length an oil is found at the bottom, from gold a very brown oil, from silver bright blue, from iron red or very dark, from mercury quite white, from lead a lead colour, from copper a deep green, and from tin a yellow colour ' (*Sud.* III, p. 108).

The method of making an aqua fortis is the same as that given by Geber though less detailed. The phrase ' in this aqua fortis purify a silver ', has an alternative and more intelligible reading ' Purify this aqua fort with silver '. The process was well-known and is described by Biringuccio in 1540. It presumably had the effect of removing chlorides, but this idea, and the futility of such a purification for acid to which sal ammoniac was immediately to be added could not be appreciated in the then existent state of chemical knowledge. The addition of sal ammoniac was necessary if the ' water ' was to dissolve gold, and in the passage in Geber referred to above this addition of sal ammoniac is also mentioned and it is added that this water will dissolve gold and silver.

In the aqua regia obtained by the addition of the sal ammoniac to the aqua fortis the metals were placed in the form of beaten-out leaves, which would facilitate their solution, a precaution the more necessary if the acid were in a dilute form. An alternative reading gives ' gecalcionirt ' for ' gelaminirt ', but both eventualities are allowed for by the paragraph which follows that quoted in extenso above, in which it is pointed out that not all metals can be reduced to an oil in this way, but that some must be prepared beforehand, as mercury is to be sublimed, lead calcined, copper made into flowers of copper, iron into its crocus, tin reverberated, but that gold and silver will readily submit. This may only be an echo of the routine alchemical procedure, in which it was customary to bring the metals to these ' dead ' forms before attempting the various successive stages of the transmutation, and indeed it is difficult to see that on balance this process would not make things worse rather than better. In the case of iron there is the possibility that if it were used in the metallic form and the nitric acid were sufficiently pure and concentrated that it would be rendered passive, and so the reaction would cease, but the realisation of these conditions is unlikely. On the other hand the

possibility that in the preparation of the crocus of iron, *i. e.* its oxide, the temperature used in the process would be high enough to make the product difficult to dissolve in acids is also to be reckoned with. In the case of copper an acid which would readily dissolve silver and gold, would also very readily dissolve the copper metal, and no advantage would arise from preparing the sulphide first. In the case of lead there is the possibility that the reaction might be stopped at an early stage by the formation of a protective coating of relatively insoluble lead chloride, which would be obviated if the oxide were used. The case of tin, however, is crucial, as the metal will dissolve readily in the acid, whereas the stannic oxide obtained by reverberating the metal is unattacked by any acid except concentrated sulphuric. In view of these conflicting results it is impossible to decide whether we can regard this paragraph as the result of actual laboratory experience or not.

It is not easy to be certain what compounds would be obtained from each of the different metals. Gold would form its chloride, and this accords with the colour obtained. Silver would result in a mixture of nitrate and chloride, which should of course be colourless, but the small proportion of copper found in all specimens of silver not chemically purified would explain the azure colour. The mercuric compounds would be colourless. The red-brown colour of ferric chloride solution fits in with the colour given, while copper chloride in strongly acid solution is, of course, deep green. It is not easy to decide what is meant by the lead-colour, which lead was supposed to give, probably an impure white or grey, as of metallic lead. The mixture of products obtained from tin would vary considerably, with the concentration of the acid used, and the conditions of the reaction, but whatever proportions of metastannic acid, stannic chloride and stannous chloride were obtained, these would all be colourless if pure, but in practice the metastannic acid produced has a yellowish tint. The tin would almost certainly contain some lead, but this would not make much difference to the colour.

It is worthy of note that Paracelsus has here obtained a series of compounds, almost all of which are much more affected by heat than the general run of inorganic salts ; these include auric chloride, mercuric chloride, stannic chloride, and to a less extent cupric and ferric chlorides, and a series of nitrates of all of which are affected to some extent by heat, in such a way that the change is made visible by the evolution of the characteristic brown fumes of oxide of nitrogen.

The general agreement between the results described and what would be expected is of interest, but still more so is the description of a *general method* of preparing a series of similar compounds which is an important step towards the recognition of compounds as falling into classes, and one which is characteristic of the whole book.

The first step has thus been taken towards the separation of the elements of the metals by bringing these into solution, which cannot be done while they

are in their metallic condition. The next step is to add to the ' oil ', obtained as above, two parts of fresh aqua fortis and leave the whole to stand for a month in horse-dung, *i. e.* leave it to digest itself in a temperature slightly above that of the air. No doubt this would help to clarify the liquid by bringing into solution any deposit of oxide or hydroxide left over by the first process.

> Next distil it on a gentle fire so that the matter coagulates itself at the bottom. And the aqua fortis (that) is thus driven over (*so heruber gangen ist*), distil this *per balneum*; there you find two elements together. And not the same two elements in all metals, but from the gold there remains in the bath the elements of earth and water. Air is in all three, and the element of fire remains at the bottom, because the substance and tangibility of gold is coagulated from fire, *ergo substantia conveniet in substantiali*. From silver there remains in the bottom the element of water, and there remains in the bath the element of earth and fire, for the substance and corporality of silver arise from the cold and humid and is of a fixed nature and cannot be elevated. From mercury fire remains at the bottom and earth and water are elevated. From copper also fire remains at the bottom and earth and water remain in the bath. From lead the element of earth remains at the bottom and fire and water are had in the bath. Now from tin air (*aer*) remains at the bottom, and fire, earth, and water are elevated from it. It is to be noticed that in tin air gives a body, but otherwise in no metal, although some part of it rises up together with the other three and remains unseparated and intermixed with them, yet this air is not corporeal air, but adherent (*mitleusig*) which is not to be separated ' (*Sud.* III, p. 109).

The meaning of the second sentence ' the aqua fortis (that) is thus driven over, this distil *per balneum*, there you will find two elements together ' has to be interpreted in the light of the paragraph as a whole, which seems to mean that as a result of the distillation on a gentle fire the salt, or mixture of salts, is obtained in a solid or corporeal condition in the bottom of the flask, while the liquid part, or aqua fortis, is collected in a receiver from which it can be redistilled *per balneum*, so as to separate the two elements which in each case are to be found in the distillate, though the details of this further separation are not immediately given.

The association of fire with gold may arise from the alchemical association of the sun with gold, or merely from the colour of the product, which whether it were gold chloride, or gold obtained by stronger heating of the chloride would by its colour suggest fire. Presumably the two elements ascribed to the distillate are decided on by seeing what element appears to be left over, assuming that in all cases except that of tin, air is accounted for as being in all the other three. The assignment of water to silver is not usual, but would seem to arise here from the appearance of the product which would either be fused silver nitrate, or a highly concentrated solution of silver nitrate, both of which would naturally suggest water. Mercury is often associated

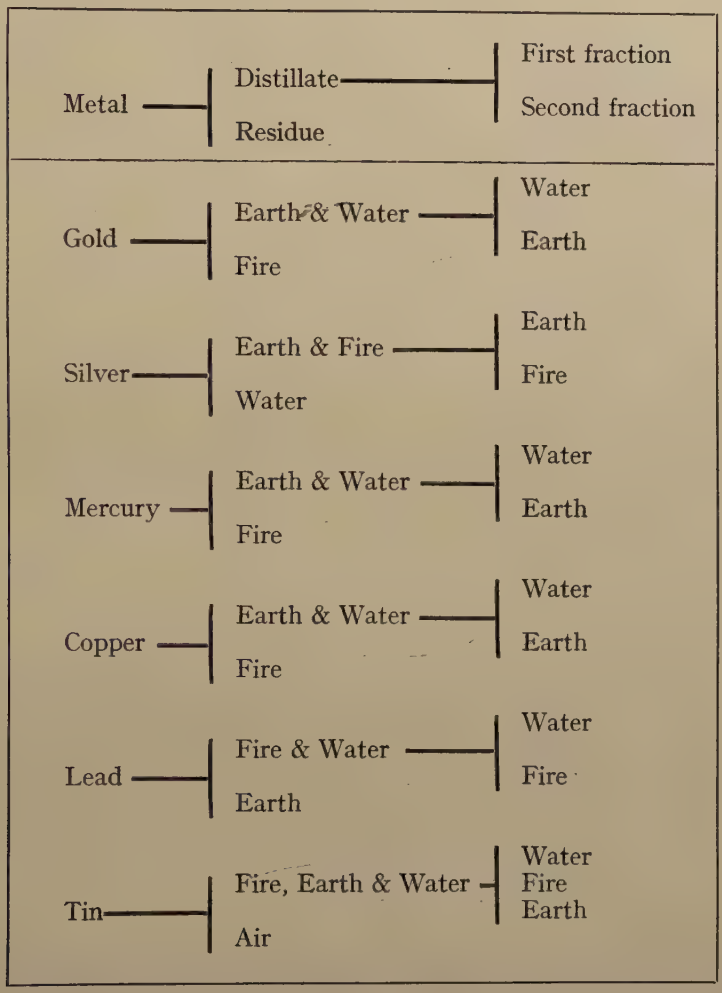
with water in alchemical writings, but here the explanation of referring the product left behind to fire may arise from the fact that the gentle heating of mercuric nitrate produces mercuric oxide, which by its red colour might be likened to fire, and perhaps the heavy brown fumes of the nitrogen peroxide produced in the process might confirm the notion of earth being distilled over. A similar explanation would apply to the case of copper. In the case of lead, if a confused mass of lead nitrate and lead chloride were left, the appearance of this, together with the normal alchemical view of lead as of a somewhat earthy nature, would make it plausible to ascribe earth to it. On the other hand if it were heated strongly enough to bring about the decomposition of the nitrate, the resulting litharge might equally be considered as mainly fire, in view of its colour and its high specific gravity. For some reason iron is left out. The statement concerning tin is in some ways the most interesting, as what is left behind is stated to be corporeal air. This becomes immediately intelligible if we assume that the product we are dealing with is stannic chloride, which both by its fuming nature and the readiness with which it can be boiled off would naturally suggest air. The difficulty is to assess how much of the product would be obtained by heating tin with a mixture of nitro and hydrochloric of unknown proportions and unknown strength to unknown temperatures after standing in the warm for a month. There is no difficulty arising from the fact that stannic chloride was formerly known as '*Spiritus fumans Libavii*'; for Libavius, though describing its preparation, makes no claim to be its discoverer.

The concluding paragraph of the chapter on the separation of the elements out of the metals seems to aim at bringing the separation down to its final form of obtaining all three elements in separate glass bottles.

> 'Now it is thus to be noted that the remainder, that is the corporeal element at the bottom, is to be reduced to an oil again with fresh aqua fortis through a bath. Thus is this selfsame element complete and perfect; and retain of it one part. The other part separate thus. Set it in sand and drive it gently, the water goes over first, afterwards the fire. It can be known by the colours which of the two remains behind. But if the element of water and earth remain the water goes over first and the earth afterwards. But if the earth and fire remain the earth goes over first and afterwards the fire. And if water, fire, and earth remain together the water goes over first, then the fire, then the earth. Thus the elements should be kept in special glasses, each according to its nature, as that from gold is hot and dry, without any other property, likewise also the cold and moist and the cold and dry. Thus also is understood of the others. So it is to be understood that the corrosive nature of the *aqua fortis* is to be removed from the elements, as we say when dealing with the quintessences' (*Sud.* III, p. 110).

It looks almost as if Paracelsus here realised that he had not dealt with the separation of the two elements in the 'bath' and so starts over again, but this time collects the two elements separately, as he does later on with

the quintessences. If we consider this combined process we may tabulate it thus :



Scheme of Paracelsan separation of elements from metals.

It is noteworthy that in every case where water is considered as one of the distillates, it is said to come over first, which is very sound. It is easiest to form a picture in the case of a strong solution or paste of lead nitrate, which on heating first gives off water, then brown fumes, which phenomenon might lead to the remark that it can be known from the colours which remain behind (*i. e.* comes over second), while the massicot or litharge left behind is the earth. In the case of copper and mercury, if the brown fumes are considered in this

case as ' earth ' we get a similar result, but it is not possible to get a consistent explanation which is even plausible.

What did Paracelsus obtain as the result of this attempt to separate the elements out of the metals ? In each case he obtained an ' oil ' which is a solution of a compound of the given metal, and this, he says, has the element complete and perfect. He also obtained various distillates which, with the possible exception of that from tin, contained nothing of the metals concerned, but which he thought of as containing some element from the metal, and he supposes that this product will have a special complexion corresponding to the element in question. When he used his ' oils ', he did in fact introduce metals into medicine, with results of which the details are available. When he used the liquids he had carefully collected into his array of labelled glasses, he was generally dealing with substances that had no metallic content. How far he prescribed these substances as a result of observing their actual effects on patients, and how far he worked on some *a priori* basis of complexions, it is hard to say, and probably both had an influence on his judgment. It is noteworthy that he recognises the need for neutralising the excess of acid, as the failure to do this was often urged against him by his later opponents.

From this detailed examination of what is perhaps the most coherent part of the best book of what is said to be his most important writing on medical chemistry we may draw some tentative conclusions.

1. Paracelsus clearly had some first-hand acquaintance with routine laboratory procedure, but lacked the gift or means of describing this clearly, in which respect he does not differ from most of his contemporaries. His obscurity may also be due to the ancient alchemical tradition of not being too explicit in declaring what was to some extent secret—part, as it were, of his policy of not exposing such things to the gaze of idiots. Darmstaedter suggests that it is because the processes were so well known, and that the only originality of Paracelsus in this matter is in applying this process to medicine, but he gives no evidence for this view.

2. Paracelsus had no correct idea of the course of the chemical changes involved in the processes he described, for he thought that he had separated out liquids containing ' elements ' of the metals, when he had for the most part only obtained distillates containing more or less nitric or hydrochloric acid.

3. In spite of this weakness he achieved two important general results ; namely, to introduce the metals into the armoury of medicine, which was to lead to work that revolutionised the whole conception of chemistry, and to familiarise the chemical world with the idea that things can be arranged in chemically similar classes the members of which were susceptible of chemically similar processes ; whereby we reach the two important notions of chemical classes, and chemical processes.

The separation of the elements out of the Marcasites (*Sud.* III, pp. 110–11) follows much the same lines, but presents two additional points of interest. The first is that, in order to get these refractory minerals (probably various kinds of pyrites) into solution, Paracelsus directs that they shall be mixed with an equal weight of salt-nitre, beaten up very small and then heated. The product is to be ground up and then treated as the metals were. The preliminary process of heating with nitre would normally convert the various pyrites to sulphates, and suggests an acquaintance with practical technology, even if the theoretical side of the process was not understood. The second point is that, in directing how the oil obtained by treating the product of the heating with aqua fortis is to be split up into elements, he says that from the golden marcasites it is to be separated in the same manner as for gold, that from the silver marcasite as that from silver, that from the bismuth as for lead, the zinc as for copper, the talc like tin, the kobolt like iron, and so on. Darmstaedter sees in this table the first step towards the idea of chemical identity, and as long as this notion is not pressed too far it may be valid, even though it seems as if Paracelsus were rather far out in the details, being led by rather superficial resemblances as when he associates gold marcasite (probably iron pyrites) with gold. What he means by ' wismat ', ' zinetus ', and ' kobolt ' is not easy to determine, and it should not be lightly assumed that they represent what we term bismuth, zinc, and cobalt, or their ores.

Similar methods are used to extract the elements from stones (*Sud.* III, p. 111), but as a preliminary these are powdered and mixed with ' sulphur vivum ' and cooked for four hours on an athanor in a luted pot ; then washed, dried and treated with aqua fortis as before. Clear stones are to be treated as for gold, white and bluish as for silver, etc., the whole table of equivalents being completely arbitrary and in no way connected with chemical nature of the stone concerned. What is meant by ' sulphur vivum ' it is not easy to determine, nor is it easy to follow the argument of Darmstaedter, who takes the line that all stones are silicates, and therefore we may conclude that something equivalent to fusion mixture is needed to bring them into a form which would be susceptible of the action of acids, and that therefore ' sulphur vivum ' is crude sulphur in which the accompanying minerals provide the necessary flux. The obvious objection to this suggestion is that the list of minerals contains substances which are not silicates such as alabaster and marble, though the failure of the method in these cases would be masked by the subsequent solution of the carbonates in the acid. A possible suggestion is that it was only another name for the well-known liver of sulphur which would contain considerably more active alkali than was likely to be found in the impurities of native sulphur.

The remainder of the book is less valuable. The elements are to be extracted from oleaginous things by first extracting with aqua ardens (*i. e.* distilled spirits of wine, of which Paracelsus makes considerable use) and are then to

be distilled in fractions; the aqua ardens comes over first, then the air, then the water, lastly the fire, and the earth remains at the bottom. Herbs are allowed to stand with water till they 'putrify' (*i. e.* undergo some sort of change, as this word has a very wide significance in Paracelsus) and then are distilled. Similar methods are used to extract the elements from fleshy bodies, *e. g.* fish, 'allow to putrify exceedingly well first', watery bodies, *e. g.* urine, and so on. There is a lack of any precise experimental details, and towards the end of the book the separation of the elements from the elements of fire, air, water and earth show Paracelsus at his weakest, *e. g.* in the case of air it is shut up in a glass for a whole summer and is changed into water which daily increases more and more; it is then to stand in a dung-bath for a month, then distilled, when the elements will separate out in the usual way.

Towards the end of this book he writes:

> 'Now we will make clear according to our purpose the separation of the pure from the impure, which is only achieved in the way we shall show in connection with the arcana and potable gold, and in consequence is not dealt with here, although the beginning of the process is not exactly the same as in the preparation of the arcana and magisteries. Yet in the end part the mode of preparation which is adopted is the same as in the separation of the elements, for in these the elements were separated and afterwards each single element is purified in itself from its impurity so that there may not arise from it any deformed thing or impediment, which otherwise might easily happen' (*Sud.* III, p. 117).

This *scheidung puri ab impuro* is a fundamental doctrine with Paracelsus, and many consider it his most important contribution to chemistry, seeing in it the beginning of the notion of chemical purity. In the passages quoted from the *Labyrinthus* above (pp. 39–40), the ideas of pure and impure are of the very widest possible connotation, and mean little more than removing the gross dross. Viewed in the light of the teaching of the *Paragranum* alchemy prepares the arcana, which are almost of a spiritual nature. In the passage just quoted both these views are implied, for the separation of the pure from the impure is connected with the preparation of the arcana and potable gold. Apart from this, and the suggestion of a general likeness between the work of preparing the arcana and magisteries on the one hand and the separation of the elements on the other, not much light is shed in this place on the details of the processes by which this purification is to be achieved. The idea of chemical purity may be here in germ, but very considerable growth is needed before it has developed to anything recognisably like the modern concept.

(8) *Practical Operations described in the Archidoxis.* (*b*) *The Preparation of the Quintessences.*

Book III of the *Archidoxis* deals with the Quintessences. As a preliminary to dealing with their extraction Paracelsus makes a distinction between the

quintessences of the metals and the potable metals, both of which are liquids, which do not mix with each other, as cream separates from milk. The fatness of the metal is white, but the quintessence is coloured. Then follows a description of the quintessence :

> ' The quinta essentia is a ' *materia* ' which is extracted bodily from all things, and from all things in which there is life, separated from all impurity and all that is mortal, made subtle and purified from all, separated from all elements. Now it is to be understood that the quinta essentia alone is the nature, power, goodness, and medicine, which is shut up in things without a hostel (? herbrig) and extraneous incorporation, further it may be the colours, the life and the property of the thing, and is a spirit like the spirit of life, with this difference that the spiritus vitæ of the thing is permanent and the spiritus vitæ of man is mortal ' (*Sud.* III, p. 118).

This eulogy of the quintessences gives us little insight into their chemical nature as conceived by Paracelsus. There is much more of the same sort. Their incorruptibility is connected with their predestination. They are considered as being present in very small quantities just as a small quantity of saffron can colour a large quantity of water. Further, while above the elements and separated from all elements, they are not to be thought of as a fifth element.

> (die quinta essentia nit ist ein fünft wessen uber die elementen ' (*Sud.* III, p. 119.)

Some of these notions are probably of great antiquity. At times the distinction between the quintessences and the arcana is not very clear, for they both have a somewhat spiritual nature, and marvellous qualities.

The preparation of the quintessences of the metals is carefully, though not clearly described :

> ' Dissolve the metal to water, and distil it *per balneum* while the action is going on (*durch das putrificiren*) till it is reduced to an oil. Distil this oil *per alembicum* in a small phial, leaving part of the metal behind, which is again reduced to an oil and distilled over till all the metal has come over. Then put it to ' putrify ' for a month. Then distil it all over on a gentle fire and take away the vapours which come over first (*i. e.* change the receiver). The two thick colours come over, one white, the other depending on the kind of metal employed. When they have all come over, separate them from one another in a receiver, so that the quinta essentia remains at the bottom and the white-coloured body swims on top. Separate them by means of a funnel and place the quinta essentia in another phial and pour in purified ' vinum ardens ' and let it stand till it is quite sour (*sharf*). Afterwards separate it from the quinta essentia and add a fresh quantity and repeat the process till it is no longer found to be acid. Then add twice distilled water and wash it to sweetness. Then keep it, and thus is the quinta essentia prepared. The white body if you reduce it gives a white malleable metallic body, but it cannot be said what sort of a body it is ' (*Sud.* III, p. 129).

As Dorn[9] points out (*Com.* 185-6) Paracelsus does not tell us what kind of water is to be used, but that this must be inferred from what has been said before, or from what he says later about the quintessences of the marcasites, where corrosive waters are mentioned; moreover this, Dorn adds, is typical of Paracelsus's method of teaching. Darmstaedter remarks with all too much truth that in his recipes Paracelsus often omits the name of one important ingredient. This seems to have happened here. The detailed nature of the directions given, and the phenomena to be observed, have all the ring of a process actually carried out, but in the absence of any knowledge about one vital ingredient one can only guess as to what it is all about. The most attractive guess is that in the process sweet spirit of nitre is obtained, which would fit in with the heavy nature of the oil obtained (sp. gr. 1·11), its relative insolubility in water and the reference to its sweetness and the washing necessary to free it from acid fumes. Both the essential ingredients are mentioned, the nitric acid (by implication) and the alcohol. There are difficulties of course, the alcohol is not added till the process is over, and then only to purify it in some way. The metal plays no part in the process and, of course, there is at best only a very slender basis for this hypothesis.

It is clear from this account, and even more so from the account of the treatment of the marcasites, that the metals were left behind from the start and that the quintessences of the metals contained nothing of the metals. It seems hard to make sense out of the reference to the thick white colour, as it is clearly something which has been distilled over, but which on the other hand when reduced gives a metallic body with the characteristic metallic property of malleability, though its exact nature cannot be ascertained apparently. It is hard to work in a reference to stannic chloride into the general context here. What does emerge clearly is the care that Paracelsus takes to free the final product from all sharpness by washing with alcohol and water, once more showing how baseless were the accusations which were made against him by the Galenists on this very matter. As a matter of practical interest it may be noted that Gerard Dorn adds that the separation may be done either by a funnel, or by a syringe (*Com.* 186).

The recipe for the quintessence of the marcasites begins by directing that they shall be well powdered, and then one pound digested for two or three months with two pounds of corrosive water in a pelican till they are all reduced to a liquor, which is wholly distilled over by fire and an oil comes over, which is then treated as for the metals.

The quintessence of salt is obtained by distilling water off from salt solution, throwing the water away, and repeating with digestions for a month each time, till the ascending water is no more sweet, what is left in the bottom is the

[9] Commentaria in Archidoxorum Libros X. D. Doctoris Theophrasti Paracelsi, Magni, Terque maximi Philosophi ac Medici prae cunctis excellentissimi; Per D. Gerardeum Dorneum Francoforti MDLXXXIIII (cited as *Com.*)

quintessence of salt, and has the power of seasoning as much meat with half an ounce as would be done by half a pound of ordinary salt. Here clearly we are in the realm of fancy.

The process for making quintessence of pearls begins by dissolving the pearl in vinegar, the vinegar is strained off and boiled to dryness, and the product washed with water, and powdered, giving the quintessence. The process for making quintessences of burning things, growing things, and spices is more intelligible, consisting essentially of extracting them with alcohol, and distilling, the quintessence being in the distillate.

The chapter concludes with the reminder that the quintessence is the separation of the ' virtues ' from the body, and in it all the goodness, medicine and being consist.

It is to be noticed that in each book of the *Archidoxis* there is a steady deterioration in quality as it proceeds, and that each book is of less value as a whole than the one which preceded it.

(9) *Practical Operations in the Archidoxis.* (*c*) *The preparation of Arcana.*

Book IV deals with the arcana which loom so large in the Paracelsan scheme of things. We have already noted their importance in the *Paragranum* (p. 000) ' That alone is an arcanum which is incorporeal and immortal, possessing eternal life, above the understanding of nature and the knowledge of men '. ' They have power to alter, to change, and to renew, to restore like the arcana of God, according to their judging ' (*Sud.* III, pp. 138–9). There is more on the power and the virtues of the arcana, their eternal qualities, their capacity to conserve health, drive away diseases, and exhilarate the sad mind. The arcanum is the whole virtue of a thing but exceeds it a thousand-fold. The arcanum of man is the whole gift and virtue of that which he retains to eternity. On the whole the account given in the Archidoxis is less clear than that of the *Paragranum.*

There are only four arcana, as Paracelsus has known since his childhood. That of ' First Matter ' which renews youthfulness, that of the Stone of the Philosophers which cleanses the human body as fire cleanses the spotted skin of the salamander, the *mercurius vitæ* which makes nails and hair grow again, and the tincture, which makes gold from silver, and takes corruption from men. That we have left the realm of chemistry behind, is then further emphasised by an excursion into the theology of the eclipse during the time of the Crucifixion.

It is not possible to attach any chemical meaning to the vague directions given for the preparation of the arcanum of first matter, which is made from undefined first matter, and ' monarchy '. (rec. de prima materia in flaccum, lass digeriren in digestione resoluta auf ein monat zu welchem hernach seze die addiz monarchiae in aequale pondus. After digestion for another month,

it is distilled). Paracelsus apologises for the brevity of the description of the process, but points out that thereby there is less liability of error creeping in !

As to the philosopher's stone, he makes no claim to know the teaching of others so he will give his own.

> Take the element of mercury and separate the pure from the impure. Then reverberate it to whiteness, sublimate it with salmiax till it is resolved, then calcine it and resolve it again, then set it in a pelican and allow it to digest for a month, coagulate it into a body, which will not burn nor will it distort, it remains also uncorrupted (*Sud.* III, p. 147).

Clearly Paracelsus has no intention of revealing the secret of the stone.

A point of considerable interest arises when Paracelsus explains how it is that the Philosopher's stone has the numerous wonderful powers that he describes ; for this does not arise from anything in the nature of the *thing*, but from the power and subtlety of the *practice*, which seems to mean that it arises not from any chemical properties which it possess as concomitants of its chemical nature, but from some property, induced by a communication of power from the processes merely because they are processes. The text is worth reproduction :—

> ' The explanation of the power which the stone has to drive out so many strange and wonderful diseases is not to be found in its complexion nor its specific form, nor indeed in its own proper character or other attribute, but arises from the power of the subtle practice which is brought about by the preparations, reverberations, sublimations, digestions, separations, distillations, and manifold reductions and resolutions. All these operations constitute in the stone a power and acidity which it did not possess initially, but which were afterwards bestowed ' (*Sud.* III, p. 145).

To make it quite clear Paracelsus gives the example of honey, which of its nature is sweet, and not acid, but which can be worked up till it is more acid than any aqua fortis or corrosive sublimate. This sharpness does not come from the nature of the honey, but is induced by the process. It is not easy to see what process brings honey to this extreme of acidity, though no doubt by alcoholic and acetous fermentations and subsequent distillations it could be made to give a strong vinegar. The point of importance is, however, that Paracelsus does not seem to think of a series of chemical processes transforming substance A into substance B which has a new set of properties, but rather as if the processes by some virtue of their own induced in substance A the new set of properties.

The *Mercurius vitæ* is made from *mercurium essensificatum*, which is first purified and then sublimed with antimony so that they both ascend together and become one. The product is resolved on a marble and coagulated four times. This gives *Mercurius vitæ*, which comforts us in old age.

Here clearly the problem is what is meant by *mercurium essensificatum*? If it is assumed to be mercuric chloride, which was well known, then if well ground up with antimony (either the metal or one of its compounds) the product with the lowest boiling point would be antimony chloride, which would be the first to be sublimed. This if left exposed to air on a marble slab would readily deliquesce or 'resolve', and would then be coagulated four times, which would probably lead to the formation of a certain amount of the oxy-chloride, reducing the tendency to deliquescence. It can hardly be thought, however, that the oxy-chloride of antimony could give any comfort to old age.

The fourth arcanum, that of the tincture, lacks any concrete chemical content and works in an obscure way. Paracelsus connects its medical properties with ancient alchemical notions of the tincture which when added to the metals imparted certain properties to them.

It seems that the meaning which Paracelsus attaches to the term 'Arcanum' in this book is much more restricted than in the various quotations given above from the Paragranum (pp. 35–39). Here it seems to be applicable only to a few very secret remedies, and retains the original meaning of the word as its primary meaning. In the wider sense in which the arcana are normal remedies for diseases (pp. 35–6) the word would include not only this restricted and highest class but the quintessences, the magisteries, and all the other remedies described under different headings in the *Archidoxis*.

(10) *Practical Operations in the Archidoxis.* (*d*) *Magisteries, Specifics and Elixirs.*

Book V of the *Archidoxis* deals with the magisteries, and marks a new phase in the type of operations. So far all the preparations are extractions or separations, those that follow—magisteries, specifics, elixirs, and medicines for external use—have in common the fact that they are made by compounding things together, though the ingredients of the compounding may have been made by a previous process of extraction.

> 'A Magisterium is not brought about by the process of separation or preliminary extraction of the elements, but by the process of addition in which the same material is both wrought and retained. Its power and virtue do not arise from its initial nature, nor from its specific form as such, but from the process of mixing, by which these powers are evoked' (*Sud.* III, p. 153).

Paracelsus makes the meaning of this definition clear by example. Vinegar when poured into wine, makes it all vinegar, and this is a magistery, but when honey is poured into wine the wine is not turned into honey, and this is not a magistery. Wine and vinegar are of like nature in power, taste, and savour, and some such degree of likeness is necessary for the preparation of a magistery. In this process the original nature is as it were retained in a concentrated

form ; hence, in the magistery of the metals, no corrosive may be used, as this would corrupt their essence, and temperate things alone are suitable.

Dorn (*Com.* 245) makes the point that the explicit reference to the lack of necessity for a preliminary separation of the elements in this case implies that it is necessary in the preceding case, though there it is not mentioned. This he said would occasion no difficulty as Paracelsus was not writing for illiterates or the uninitiated, but especially for his disciples who have practised the art for many years. Both these points should be borne in mind in interpreting the writings of Paracelsus.

The most interesting of the magisteries are those of the metals, which are otherwise known as the potable metals.

> Take circulatum well purified and in the highest essence. In it place thin beaten or filed metal which has been wrought and cleansed to the most pure and subtle condition. Place the two together and let them circulate for four weeks so that the sheets of metals are reduced by the temperate medium to an oil which floats on top like fat, coloured according to the kind of metal. Skim this off by a silver ' drawer ' (*attractorium*) to separate it from the circulation. Thus you make potable gold, potable silver, and the same for the other metals, which are fit to be drunk and consumed without any harm (*Sud.* III, p. 157).

This recipe derives directly from Rupescissa. The *circulatum* is made from wine distilled and redistilled to an ardent spirit, then refluxed in a sealed vessel at a gentle heat for some forty days. It is said to separate into a clear sky-blue upper layer and a turbid lower layer (a process which does not accord with anything in modern chemistry). By quenching hot gold leaves in this, potable gold was said to be obtained. The recipe of Paracelsus is a mere variant of this.

Darmstaedter is anxious to see in the preparation of the potable metals something like the preparation of colloidal metals, and so points out that colloidal gold can be obtained under the right conditions by the action of alcohol on gold chloride, but recognises the difficulty that the use of aqua regia is ruled out. It may be further pointed out that colloidal metals are difficult to keep in the colloid state unless ' protected ', and that it is hard to see how any of them could be described as an oil floating on top of a solution of relatively low specific gravity, such as one containing a high proportion of alcohol. The process, like the majority of alchemical recipes, is not in accord with modern chemical knowledge.

The magistery of gems is brought about by grinding them up, calcining them, mixing with an equal weight of ' common nitrum ' burning to a calx, washing with vinum ardens till there is no more superfluous material, heating strongly again to a mass so that it will all dissolve in vinum ardens, evaporating this off, leaving an alkali which will deliquesce in air into a water ; this is the magistery. It will be sharp and ' kalisch ', but that is the source of its virtue.

'Gemein nitrialen' which Dorn (*Com.* 232) translates as 'sal nitrum commune', is usually some form of sodium carbonate. The course of the action would depend on the nature of the gems used, but in any case the final result of the action seems to have led to the formation of a certain amount of caustic soda which was purified by alcohol and left to deliquesce in air to form a mixture of sodium carbonate and hydroxide, which would certainly be sharp and 'kalisch', but in certain cases, no doubt, very effective for dealing with excess acid in the stomach.

Corals are to be treated in the same way as gems. Pearls are dissolved in vinegar for a month, the excess of vinegar is distilled leaving the pearls behind resolved into a water.

The marcasites require first that the true marcasite be separated from the superfluous mineral, and therefore it is ground up and dissolved in dissolving water, distilled and separated as for the metals.

Amber distilled with *circulatum* gives an oil. Turpentine, gums and rosin require first to be digested *per se* for a month, then boiled for half-an-hour with *vinum ardens* mixed with *aqua solvendi*. It is then digested for a day in a blind pelican (that is one sufficiently sealed to prevent loss through evaporation) and the oil which is on top is taken off. The interest of this prescription is the introduction of *aqua solvendi*. Working on the analogy that Dorn gives (see p. 56 above) it might seem that it could be used in the other cases in spite of its apparent exclusion. It is not clear, however, that it is the same as corrosive water.

For oils, the *aqua solvendi* is not needed, and their magisteries probably consisted of little more than solutions of them in alcohol.

He then describes the magisteries of growing things. The process for wood seems to be little more than the dry distillation of the finely chopped material. Herbs are extracted with burning wine, probably distilled alcohol, as described in the early treatises on the quintessence. The magistery of wine is rather unusual. A flask is one-third filled with very old wine, sealed and left for four months in a dung-bed. The flask then exposed to the severest winter weather till part of the liquid congeals, this part is thrown away and the rest is digested in a not too hot sand bath.

This process is a genuine one. The water in the wine freezes out and the alcohol is concentrated in the remainder: thus the result is to give a much stronger solution of alcohol. It is difficult, however, to see in what sense the result can be called a magistery, as there is no process of mixing, which is the characteristic of magisteries and the source of their virtue.

Book VII of the *Archidoxis* is entitled *De Specificis*. 'Specifics are generated from a conjunction (*zusammenfügungen*); as when mastic and colophony are compounded together they form an "attractive" which neither of them is on their own' (*Sud.* III, p. 169).

Paracelsus gives a considerable number of examples to illustrate his meaning, *e. g.* gall and vitriol produce ink, though neither of them is black, or when aqua vitrioli is distilled with salmiax it smells like musk, though neither of them has any savour. This latter is of interest as being an early mention of the preparation of dilute hydrochloric acid, though there is nothing in the context to suggest that Paracelsus realised its nature or importance, nor is it easy to see how he found any similarity in the savours of hydrochloric acid and musk.

Paracelsus explains that he does not here deal with the necessary primary preparation of the various components to be used, but only with their compounding. The prescriptions are arranged under headings according to their use as diaphoretic, purging, styptic, etc. The ingredients are mainly such things as syrups and juices, with small amounts of quintessences of the metals, or magisteries, etc., included.

Book VIII deals with Elixirs. Just as balsams applied externally preserve the dead body from corruption, so elixirs taken internally can preserve the living body. The first elixir is made from balsam and quintessence of gold, the second from salt, the third 'of sweetness' is made from tronus (presumably sodium carbonate). All these display the idea of using substances which are generally used externally as preservatives, though the idea of preserving syrups, suggested by *Elixir dulcedinis*, is not quite borne out by the use of 'tronus'. Elixir of quintessences is made from a mixture of various quintessences. The rest are of no interest.

Book IX is 'de extrinsecis' as distinct from the preceding books which deal with medicines to be taken internally. It deals with these remedies according to the type of use to which they are destined, as for wounds, ulcers. and blemishes, and on the whole contains little of chemical interest.

(11) *Conclusions* [10].

The chemical ideas of Paracelsus derive from, but go far beyond, those of the school of writers who were responsible for chemical works attributed to Lull and Rupescissa. This tradition reappears in numerous later works, notably those of Brunschwyg and Ulstadius, with which Paracelsus was certainly familiar. The characteristic idea of this school is the separation of an active 'spiritual' portion of a natural body.

The characteristic idea of the chemical works of Paracelsus is the enhancement of the activity of different kinds of matter, usually by separation, but sometimes by mixture. This activity is concentrated in a part of the body which has a more spiritual character than the crude matter and which is akin to and therefore guided by the powers of the spiritual and celestial world.

[10] The concluding section was written by the Hon. Editor from fragmentary notes left by the author.

The chemical procedures which he prescribes for the enhancing of these activities are not informed by any theoretical principles such as we know today. Such notions as the conservation of matter and energy are of course absent, as are also the idea of pure substances and of the invariable association of a group of properties in a particular substance. His picture of matter is based on the analogy of living things. Everything has a gross and subtle part, analogous to body and soul; he assimilates the chemical to the biological, not as we do today, the biological to the chemical.

The almost complete absence of chemical ideas in the work of Paracelsus naturally implies that his recipes will not follow modern chemical practice. He does not know what he is dealing with, and thinks in terms of operations (distillation, coagulation, etc.) rather than in terms of the matter operated upon. He thinks of these operations as necessarily imparting particular properties to the material operated on, irrespective of its nature. He believes very strongly in the unity and plasticity of matter and is too optimistic concerning the possibilities of altering it.

It therefore seems that the recipes of Paracelsus are such as to produce something very different from what is implied by their title; thus the quintessences of the metals are made by processes which would exclude from them the metal in question. A number of these processes display evidence that Paracelsus had carried them out: but others (such as the recipes for potable metals) seem to be taken over from earlier authors and could have given no results.

Paracelsus performed a very great service in presenting the world, for the first time, with something like a *system of chemistry*. His works are not narrowly concentrated on some specific object, such as the making of the Stone or the Quintessence, and he applied his ideas and techniques to the whole range of chemical substances known to him, and he even attempts a certain classification both of operations and of materials. Paracelsus extends the scope of the physical process of alchemy from that of a process of gold-making to the sum-total of all operations by which man modifies the materials around him, and so opens the way for the foundation of a science of chemistry. In this respect he is a forerunner of Andreas Libavius, who first attempted to include in a single work all the disciplines and techniques which we today regard as chemical, but which had previously been considered under very various headings—alchemy, pharmacy, metallurgy, and the like.

REVIEW.

Psychologie und Alchemie. By C. G. JUNG. Pp. 696. 270 illustrations. Rascher Verlag, Zurich, 1944.

MODERN scholarship has thrown much light upon the history of Alchemy; books written by competent scholars have appeared in different countries and have given us new insight into the formation of ideas which today have crystallized into a system of scientific experiment unique in the history of mankind. But the student of the alchemical texts is forced to acknowledge their utter remoteness from the modern way of thought, and if he wants to know what it is all about he does not know where to turn. There are, in fact, only three books written since the seventeenth century which can serve as an introduction to a speculative interpretation of the ideas underlying what is called Alchemy; these books are written by scholars and give the student a sincere, even though highly subjective, view of the methods of work of the alchemists.

The first book is Michael Maier's *Symbola Aurea Mensae duodecim nationum*, Francfurt, 1617; the second is Mrs. Atwood's *Suggestive Inquiry into The Hermetic Mystery*, first published in London, 1850; the third is Dr. Jung's book, which we shall discuss.

In order to understand the enigmatic and obscure language of the alchemical authors and to interpret the meaning of the many symbolical pictures and illustrations in the alchemical books, Dr. Jung, a practising psychiatrist, has drawn upon the contents of dreams as a possible key that might unlock the door to the world of alchemical allegories. Dr. Jung is a believer in the reality of the contents of dreams; for him a dream is a sign-post, indicating the direction and progress of the activity of the subconscious, which does not mean that the conscious life of the individual need be aware of what is going on under the surface. Now Dr. Jung has come to the conclusion that the pictures and imagery of dreams correspond to the symbolical concepts used by the alchemical authors, and if we accept his thesis, namely that the 'individuation process of the self' is a path of salvation of the 'self' and that this path is mirrored in dreams, propelled, as it were, by its own laws, we can see that a series of dream-symbols and a sequence of alchemical symbols have a definite resemblance. As a matter of fact, the pictorial images of many dreams resemble most accurately the descriptions given by the alchemists of the different stages of the Great Work. The dreamer experiences his dreams in sleep, whereas the alchemist, by using his conscious will, can produce his symbols for the purposes of experiment. How this is done has been taught him either by a teacher or he has gained such knowledge from the writings of the alchemists, whom he has been able to interpret in a manner corresponding with his own intelligence. His experiments have a definite object in view; he wants results, and this, according to Dr. Jung, is a state of 'higher awareness', a state of mind, which today, perhaps, is enjoyed only by the members of certain fraternities, who practise yoga, and by religious, whose goal it has always been throughout the ages. Indeed from this point of view the writings of St. John of the Cross might be said to describe the alchemical work in terms of a spiritual ascent.

Dr. Jung, we believe, is the only modern scholar who has taken the trouble to read numerous alchemical texts. He has, therefore, not neglected the

physical experimental side of alchemy ; he recognises the fact that the alchemist in the past did actually perform chemical experiments in the modern sense as far as his knowledge would allow him to do so. The goal of the physical side of alchemy was a substance which could ' transmute baser metals into gold ', or could cure all diseases, or could transform water into glass ; it was a ' universal solvent ' and *solve et coagula* was the phrase used by the alchemists over and over again. But in order to perform these alchemical experiments in the laboratory the alchemist had to induce in himself a state of consciousness that gave him the knowledge of the secrets of his craft. As the Great Work progressed in the alembic or in the oven, so correspondingly did psychological changes occur in the alchemist himself, and the inner change within the experimenter was closely bound up with the outer change visible in the substance, as this substance approached its desired state. The connection between matter and self, assumed as real, is described by Dr. Jung by the word ' projection '. Man, as the microcosmos, is not divorced in essence from the parts of the macrocosm, of which he is a reflection ; therefore man's relation to matter is one of participation, which includes man's control over matter in a psychological sense, different from our modern control, based on scientific experiment.

How, it will be asked, could a knowledge of dream-symbolism assist us in performing alchemical experiments ? We are no nearer an answer ; what Dr. Jung has done is to render us an invaluable service in explaining the process of thought of the alchemists. He has shown us that the philosophically-minded thinkers of the past had at their disposal a psychological system as subtle as his own and one which was perhaps more efficacious as far as the ' individuation of the self ' is concerned. The reason for this is that the alchemists were, in the opinion of the reviewer, acquainted with certain ' technical secrets ' which induced in the subject a kind of trance state, during which the subject was fully conscious and was able to direct his will along certain prescribed patterns of meditation, and this produced positive subjective results. In this procedure the effect of sound was important—to use the Indian word ' mantra ' would be going too far here—and certain positions of the body appear to have been used. All this is mentioned in the texts and can be seen in the symbolical pictures. The language of the alchemists, however, must be understood symbolically ; their words have several meanings,—a stumbling block to the modern reader, very difficult to surmount. No one is better fitted than Dr. Jung to explain the synthetic meaning of a symbol, and here in this book he has definitely broken new ground by showing the immense importance of thinking in symbolical terms,—terms, not merely applicable to psychological states of the self, but especially valuable when we come to investigate the origins of scientific ideas.

If we accept the definition that alchemy is a system of thought which attempts to teach a way of co-operating with the First Cause, in order to become aware of the process of generation and thus raise man to a higher state, we can only be too grateful to Dr. Jung for contributing more than any other modern scholar towards an understanding of what was in the mind of the alchemist. With his great knowledge of the mythologies of the different races and of the ' archtypes ' of the unconscious, which seem to be the same in every human being, he has been able to show us how the human soul, or the ' self ', to use his technical term, on its path to fulfilment which nothing can obstruct, uses symbols to personate the states of its progress. These symbols are frequently derived, curiously enough, from descriptions of the actions of chemical substances upon one another, or from Greek, neo-Platonic and Christian theological

terminology and from ideas formed by individual alchemists themselves. Dr. Jung insists that the meaning of a symbol includes an ' inner experience ' of the same. This then, according to him, would most decisively influence the alchemist during his experiments in the laboratory and produce certain physical results in the alembic, which is not mere chemistry in the modern sense, but a direct control over matter. Later, Dr. Jung continues, as the experimental sciences developed, the psychological counterpart, that took place within the alchemist, was overshadowed and gradually dropped away altogether and modern chemistry was born.

Dr. Jung begins his book with an introductory chapter in which he discusses the problem of the religious psychology of alchemy. The aphorism, *Aurum nostrum non est aurum vulgi*, quoted by Dr. Jung, is applied to the ' interior gold ', the result of the psychological change within the alchemist himself. But it may be permissible to ask whether the alchemist did not after all have in mind the possibility of obtaining a gold of refined physical quality, tangible and visible to the eye—many of the texts lead one to suppose this, but there are, of course, an equal number that would bear out Dr. Jung's interpretation. It is certain that Dr. Jung's ' archtypes ', as he explains here, fit into the pattern of alchemical symbolism, the unconscious ' thought ' process going on, the whole time, propelled by its own momentum. The second part of the book contains a description of 59 dreams, with commentaries and discussions about the meanings of dream-symbols. The third part, which deals with ' salvation concepts ' in Alchemy, is divided into six chapters, of which the first chapter describes the basic ideas of Alchemy and the second, the most important in the whole book, the ' psychic ' nature of the alchemical opus.

In this chapter Dr. Jung tries to solve one of the fundamental difficulties of Alchemy for the student ; how we can logically admit that there are two parallel streams in Alchemy, the ' tam ethice quam physice ' of pseudo-Demokritos. Dr. Jung thinks that, as the alchemist believed in a living spirit in matter, therefore, during his experiments with substances, the changes taking place within himself caused a similar change in these substances. Dr. Jung reiterates that the alchemist ' projected ' the changes within himself on to matter. Thus the visible transformations in the laboratory were in reality visions projected into the alchemical vessel rather than a physical chemical change or transformation in our sense of the word. It is problem atical, however, whether the physical changes in matter that are described in many of the alchemical texts, are either illusions or projections on the part of the experimenter. Are we not in danger of putting a modern psychological pattern over a system of thought based on totally different premises ? Dr. Jung, quoting from the *Liber Platonis Quartorum* (*Theat. Chem.* **5**, 101, Strassburg, 1622) substantiates his theory of the identification between the subject and the opus ; he states that in this text the *os capitis* is given as the ' vessel ' wherein the transformation (of the self) takes place, though not all readers will follow his interpretation of the words there given. This text, of undoubted Arabic origin, raises another problem : how far Arabic Alchemy has influenced experimental methods and whether works such as the *Liber Platonis Quartorum*, as Ruska has shown for another group of texts composed in Fatimite times, are not completely misunderstood and misinterpreted, because many texts of Arabic origin were written when the Islamic nations thought that they enjoyed the rule of the ' perfect man ', and in fact, many of these texts are disguised religious tracts. Dr. Jung ends the chapter by explaining what the alchemists meant by ' meditation ' and ' imagination ' and quotes